

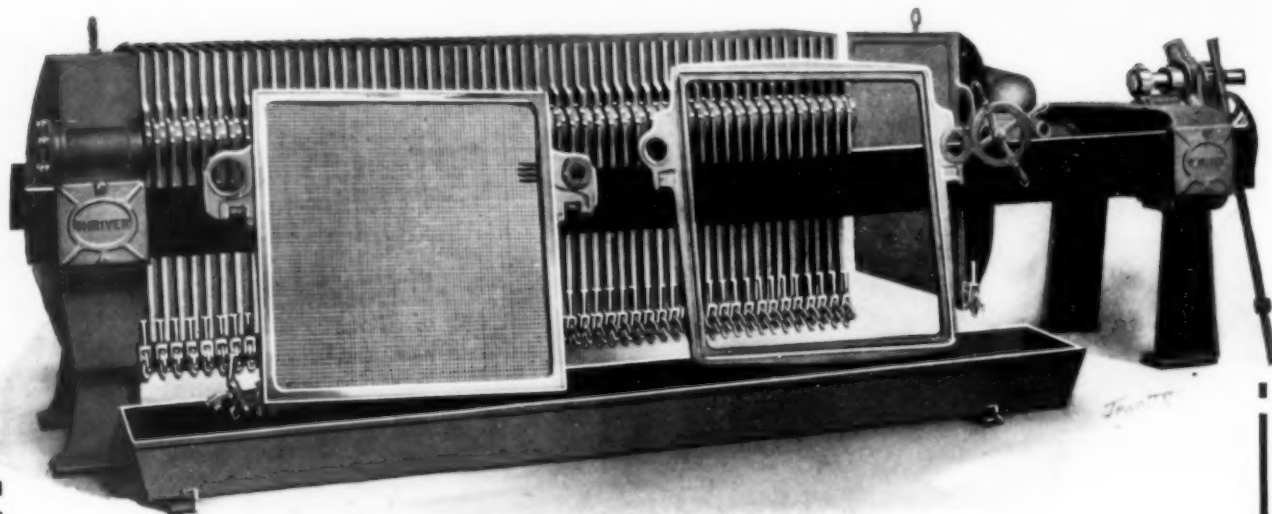
# Metallurgical & Chemical Engineering

McGraw-Hill Publishing Co., Inc.



April 15, 1917

Chemical Exposition Number  
The Annual Guide to the Industries



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# Metallurgical and Chemical Engineering

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## The Chemical Exposition

The third National Exposition of Chemical Industries, to be held at the Grand Central Palace during the week of Sept. 24, bids fair to eclipse the former gatherings. The initial exposition, held after the first year of the war, was an expression of an industry which was just finding itself in a fairly limitless horizon of possibilities. The sense of the best thought at that meeting was the crying need of an educated, appreciative and just state of mind on the part of the American public. This, happily, is in large manner becoming an established fact.

Chemists, as a whole, were quick to grasp the significance of the exposition idea, and several societies scheduled their regular meetings during the week of the second annual exhibit. The result was large and enthusiastic throngs of technical men in attendance, but with an inevitable duplication of effort and diffusion of attention.

This year the exposition holds the stage alone. Its remarkable growth will be evidenced by the wonderful collection of apparatus, machinery and products of interest to the engineer, and the imposing numbers of models and motion pictures for popular consumption. For such occasions not only furnish a meeting place for technical consultation and discussion of manufacturing difficulties, an assemblage point for the exhibition of the great natural resources of this land of ours which await the transforming touch of modern chemistry, but a place where the man on the street can get an idea of untold possibilities of science and an appreciation of its every-day application in promoting his welfare.

## The Nitrate Supply Committee's Recommendations

Nothing is usually more instructive than the problem's formulation. Ten years ago, the question would have been: "Is the manufacture of nitric acid from air practicable?" As it was recently put up to the Government's nitrate supply committee (involving the decision on a \$20,000,000 appropriation), the question was: "Which one of at least half a dozen different processes for the fixation of atmospheric nitrogen is the most practical one under present conditions for this country?"

The committee's decision, fully recorded elsewhere in this section, is in favor of synthetic ammonia, followed by oxidation to nitric acid. For the production of synthetic ammonia, the de Jahn process, a new process of the General Chemical Company, differing from the Haber process particularly in the use of a lower atmospheric pressure, is recommended. The decision involves the expenditure of less than \$4,000,000, because the

first cost is low, the power requirements being apparently lowest of all processes under consideration, so that no hydroelectric development is to be taken into account.

It should be noted that entirely independently the same conclusion on the relative cost of the different processes is reached in Dr. Maxted's paper, published in our present issue, on the development of the modified Haber process in Great Britain. So far, so good. This independent check of the Nitrate Supply Committee's chief conclusion is exceedingly welcome.

Yet there remains a certain incongruity to be explained, in that an appropriation of \$20,000,000 was made and less than \$4,000,000 are to be expended. Does this indicate rash extravagance of Congress in making the appropriation and superhumanly virtuous restraint on the part of the committee? Hardly. A much simpler explanation is that those who pushed the \$20,000,000 appropriation through Congress thought they could kill two birds with one stone. They figured that in accordance with most prominent European developments the solution of the problem of fixation of atmospheric nitrogen for the needs of this nation would necessarily be bound up with an important waterpower development requiring a large capital investment. This would have furthered two very meritorious objects: First, it would have solved the nitrogen fixation problem; second, it would have helped to relieve, at least somewhat, the present calamitous power situation in this country.

But the Nitrate Supply Committee, which was called upon to make the decision, decided that its only primary object was to select the most suitable nitrogen fixation process, and that the deplorable waterpower muddle was none of its business. As the one nitrogen fixation process most suitable for this country and for the present time, it selected synthesis of ammonia, and was particularly fortunate in discovering a new and highly promising process of American origin. Very probably this was the very best selection that could be made, and the committee and the General Chemical Company, with the chairman of its board, Dr. Wm. H. Nichols, and the inventor of the process, Mr. Frederick de Jahn, all deserve heartiest congratulations.

While the situation thus has its very bright side, don't let us now overlook the dark side. In view of the outcome, it was a mistake in the beginning to mix up the nitrogen fixation and the waterpower problems. The waterpower problem now remains unsolved. Yet, as reflected in numerous important contributions by prominent engineers and business men in the editorial section of this issue, the best interests of the whole nation require that it be solved in the near future.

### Problems Before the Chemical and Metallurgical Industries

The universal and insistent demand upon metallurgical and chemical industries, the undercurrent common to all the special articles and interviews in this issue, is for *more production*. Petroleum reserves are steadily diminishing under an enormous consumption. A shortage of twenty-five per cent in the supply of sul-

phuric acid is imminent. A famine in electrical energy at the very center of electrochemical industry is depriving industrial and militant America of essential substances. The steel works are just drawing a long breath at the end of a panicky bull market, and the copper companies are fighting a multiplicity of strikes, which has made serious inroads into an already deficient output.

Many elements, working together, are necessary for the perfection of a going concern. First, capital. A review of the By-product Coke Oven and the Dyestuff Industry shows how untold millions will be forthcoming from prosperous America to finance permanent industrial expansion. Money may be had in plenty.

Brains are more necessary than dollars. The wonderful evolution of our metallurgical processes in the last forty years is a veritable wonder of the technical world, and a source of inspiration to foreign engineers visiting our country. Chemistry, too long stifled by foreign trade combinations, has leaped to the front from a firm foundation of correct technology. Educators are realizing that real pedagogic problems exist in smoky smelters. Brains may be had in plenty—they will be needed in plenty—and should be mobilized and utilized more wisely by the Government.

Materials are required to build and operate new capacity. Oil drilling is halting for the lack of casings, piping and other essentials. Sulphuric acid cannot be supplied for a lack of pyrite. Metal production waits on a supply of basic refractories and fuel. So far as such shortages are artificially produced by criminal profiteers traitorous to America, they can and are being eliminated by governmental action through big men and patriots. So far as shortage results from a lack of natural resources, the engineer can turn prospector, discovering new sources of supply, or turn experimenter, devising substitutes or developing more efficient utilization of present stocks.

Appears a labor shortage, real and artificial, real in that immigration can no longer furnish the man-power required to match our expanding plant capacity. Artificial labor shortages—strikes—are constantly being accomplished by vicious I. W. W. propaganda or the ubiquitous walking delegate. Real labor shortage can be best combated by the trained engineer—let him devise labor-saving machinery and devices, large and small. Managers should regard it as a patriotic duty to lend every encouragement to such work; they should visit around and see "how the other fellow does it." When our armies are mobilized, short-sighted men will be forced into two alternatives by a hard taskmaster called "war" to improve the process or curtail the output. Artificial labor shortage can best be combated by true Americans, the rank and file of laboring men, in their unions and in the shops. All honor is due to the patriots within the ranks of American labor who have realized their opportunity and are leavening the mass. Their work is pregnant with infinite good.

Any thoughtful engineer cannot fail to see opportunity beckoning him from every side. It is his day! There is a man's work to do! Let's go!

## The Niagara Power Situation

By F. J. Tone

Works Manager, The Carborundum Company

One great anomaly in our war activities is that while we have speeded up every other national resource, Niagara remains throttled.

The part set for Niagara industries in the war program is a large one. They must supply the bulk of the ferro-alloys, the all-essential of the steel industry. Ferro-chrome is wanted for armor plate and projectiles. The army must have chlorine for gas shells, camp sanitation, water purification and for the Dakin solution. Explosive makers want caustic soda, potassium chlorate and chlor-benzol. Dirigibles require silicon for generating hydrogen. Destroyers want phosphorus for smoke screens. Abrasives, cyanides, aluminium, electrodes and many other products are urgently needed in the war game. The Aircraft Production Board has decided on the design of the standardized United States aeroplane motor. It will require quantities of ferrochrome for chrome steel crank shafts, chrome steel connecting rods and all parts subjected to the enormous strains of a mechanism weighing less than 2 lb. per horsepower. Quantities of aluminium will go into crankcases and pistons. The modern grinding wheel alone makes possible the finishing to limits of a fraction of a thousandth of an inch all parts of the aeroplane engine and thus the artificial abrasives of Niagara become the key to interchangeability.

To meet this war demand there is actually available 60,000 hp. less than in peace time. In 1916, 175,000 hp. was coming from Canada to the American side. Canada has now cut off half of this and the Ontario Government has authorized the expropriation of all the power which is now being exported to the United States. This complete embargo would cripple the making of war materials here, but the action is held up, it is said, only in consideration of probable reprisal on the part of the United States in shutting off coal going into Canada.

The action of Congress has been wholly inadequate to meet the situation. On June 30 Congress renewed for one year the permit to divert an additional 4400 cu. ft. of water, provided that it was to be used on generators already installed. Inasmuch as sufficient generating capacity is installed to utilize but a portion of this, the additional power is only 35,000 hp.

To help production of war materials the first relief measure should be legislation permitting the installa-

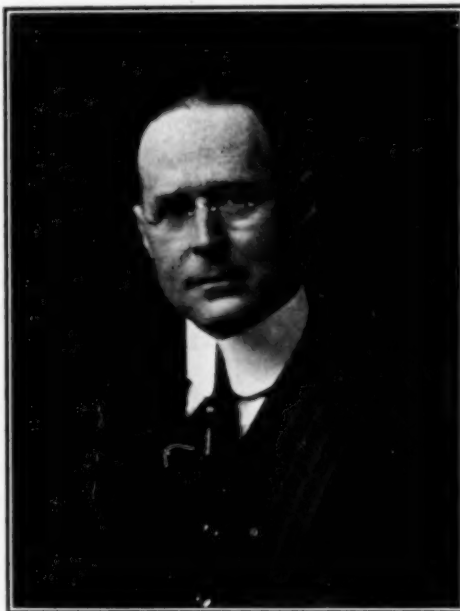
tion of emergency apparatus to use the entire amount of water allowed by treaty. Such installation could be made in twelve months. No power company however could undertake to install such apparatus without the assurance that the water could be used for a sufficient period to justify the investment. Therefore as a second relief measure, Congress should legalize the right of the power companies to use water for a fixed term of years. This would enable them to remodel their works so that the water now diverted could be used at the maximum head. The reconstruction work would cover a period of three or four years, but 300,000 hp. would be added to the power supply without diverting any additional water. It would save the nation 3,000,000 tons of coal per annum. A third measure should

be the control of erosion at the apex of the Horseshoe Falls. The recession of the crest of the Falls is now 6 ft. per annum and the Horseshoe is rapidly becoming a deep narrow gorge gathering the whole river into a central channel. Invisible current deflectors or submerged weirs placed in the bed of the river above the Falls would deflect the water over the sides of a re-established Horseshoe and would make available double the amount of water now allowed by the treaty with an actual improvement in scenic effect and a saving in the nation's coal consumption of 16,000,000 tons per annum.

Looking to conditions after the war, it requires no prophetic vision to foresee the shifting of our electrochemical supremacy to Canada and Norway. By reason of Niagara power the United States has achieved during the past quarter century a suprem-

acy in electrochemistry such as Germany achieved in the chemistry of dye products and fine chemicals. Remarkable as this development has been, it will no doubt be exceeded in the next quarter century. A score of rare elements and compounds of elements already utilized are waiting to be brought to the service of industry and he would be pessimistic indeed who would say that we will not have other developments rivaling aluminium, calcium carbide, fixed nitrogen and all the products of the electric furnace and the electrolytic cell that have revolutionized our basic industries. These advances will require the power of another Niagara or perhaps several Niagaras, and while we restrict water power development and glory in the amount of coal we burn, Canada is proceeding with a new development below Niagara which will give an additional 600,000 hp. Unless the awakening comes, Canada and Norway will control the electrochemical markets of the world.

Niagara Falls, N. Y.



*F. J. Tone*



## The American Steel Industry

Kaleidoscopic changes are the normal thing in the American steel industry, hence there is not the least occasion for surprise that the war has effected great changes. The astonishing thing rather is that it required so many months after the war started for the realization to come to the trade that the industry was to be made very prosperous by the war. Many years ago the late James M. Swank, the great statistician of the industry, observed that it always had a chill or a fever. Many years later one of his great admirers coined the saying "prince or pauper," and that has become the common phrase, though as regards conditions existing at the outbreak of the European war Mr. Swank's terminology is by far the more precisely descriptive. The industry was experiencing a severe chill. It was familiar with periods of depression and low prices separating its periods of activity and large earnings, but there had been the unfortunate conjunction, late in 1913, of the period of activity and full production inaugurated in 1913 coming to a close just as a new tariff law was enacted, greatly decreasing the duties. The trade was not in a mental attitude to see that anything good could come from the war.

On the inception of the war a theory was entertained in some quarters that export trade would be stimulated. In terms of finished steel exported directly or consumed in the production of manufacturers, machinery, etc., that were exported, the steel producing countries, Germany, England, the United States, France and Belgium, were exporting to non-producing countries at the rate of somewhat more than 10,000,000 gross tons a year, the exports of the United States comprising less than one-fourth of the total. As supplies from the warring countries would presumably be shut off, here was a chance for heavy exports by the United States. It soon developed, however, that the neutral countries were unable to finance purchases to any great extent, and they were, moreover, in possession of fairly large stocks.

The steel mills operated at about 65 per cent of capacity during the first eight months of 1914, this including the first month of the war, and then their operations decreased rapidly until they were not over 40 per cent in December. Prices dropped to the lowest level since 1898. War steel orders did not begin to appear until about the beginning of 1915, but in the second quarter of the year they multiplied to such an extent as to be considered an important factor. Late in June one of the steel interests announced that it was undertaking a small addition to its capacity, and the incident was hailed as very significant, being the first of the kind for a couple of years. Millions of tons of new capacity have since been added.

The very moderate prices that were asked upon the first inquiries for large steel rounds for making shrapnel shells, 1.10c. to 1.30c., were in striking contrast with prices paid afterwards, in many instances higher than 4c. The inability to recognize at the outset of the war that a heavy demand for steel for war purposes

would be created is likewise in contrast with the common appraisal when the prosperity began that it was due directly to orders of war steel. The fact is that the production of steel in 1916, minus all exports, both peace and war material, was materially greater than the domestic consumption in any year prior to the war. This increase was due chiefly to the enormous favorable balance in the foreign trade, produced only in minor degree by the exports of steel and manufactures thereof. The country as a whole was made prosperous, with full employment and plenty of money, hence it naturally consumed steel.

The present rate of production is about 33,000,000 tons a year, or at the rate of perhaps 90 per cent of capacity, operations being interfered with by shortages of labor and transportation. As representative of "steel production" the statistics of the production of ingots are frequently quoted, but they are really merely the record of the ingot scales, a portion of this tonnage going into scrap crop ends which goes back through the steel-making process. The production of rolled steel, the commercial product, is about 76 per cent of the ingot tonnage.

The reversal of feeling on the part of steel buyers, from the attitude of extreme dejection before the war started and the added fear that during the European war normal business conditions could not be expected, was so complete that it quite overshot the mark, and market prices were bid up to levels the producers themselves had never had the courage to expect. This process did not cease until June of this year, when finished steel prices were approximately quadruple the very low prices of December, 1914, and more than triple the average prices for either ten years or fifteen years preceding the war. A readjustment is now being forced, since the price situation was one that could not possibly continue for any length of time.

Conditions since the war started have not, on the whole, been favorable to the making of much technical progress. When it has been desired to increase capacity the new construction was expected to pay for itself, if at all, in a short time, perhaps not much more than a twelvemonth, and relatively little consideration was given to prospective earnings after the war. Hence time was the all-important element in new construction and divergences from accepted practice were not in favor. Despite scarcity of labor and materials many new records for quick construction have been made. As an instance, starting with a foundation previously provided, the Cambria Steel Company built a blast furnace complete in fifty-seven days, blowing it in on July 3, 1917.

The large amount of new construction of by-product coke ovens was not due directly to the fact that Germany was blockaded, causing a heavy demand for coke by-products. There were in operation by-product coking plants that were recovering scarcely any of the valuable by-products, and the first requisite would be to add the necessary departments to these already established plants. The new construction of by-product ovens was due rather to the general prosperity and the

ease with which the construction could be financed. Production of by-product coke in 1913 was 12,714,700 short tons, representing about 90 per cent of the existing capacity. The production in 1916 was 19,069,361 tons, representing the full average capacity for the year. The capacity at present is in the neighborhood of 24,000,000 tons a year, representing about 40 per cent of the country's coke requirements.

One surprise developed in the striving for maximum output at all points was the production of the blast furnaces. Based upon the output in 1912 and 1913, with allowances for the percentage of inactivity and the new furnaces completed in the two years, the available capacity for 1915 was not rated at more than about 35,000,000 tons a year, yet a rate of 38,000,000 tons was reached at the close of 1915, and the old furnaces have since made even a larger tonnage. With about three new furnaces completed in 1915, four in 1916 and nine thus far this year, the commercial capacity is probably somewhat in excess of 42,000,000 tons, but the rate of production is nearly 10 per cent less, chiefly on account of shortage of coke.

The largest annual outputs made by the various countries before the war, in terms of steel ingots and castings, made a total of about 75,500,000 gross tons, divided approximately as follows: Central Powers—Germany, Luxemburg, Austria, and Herzegovina—28.2 per cent; Entente Allies—England, France, Russia, Belgium, Canada and India—27.6 per cent; neutrals—United States, Italy, Sweden, Japan and China—44.2 per cent. Changes during the first year of the war included the transfer of Japan and Italy from the neutrals to the Entente Allies and the occupation by Germany of Belgium together with territory on which was located nearly three-fourths of the French steel-making industry.

In entering the war the United States occupied a peculiar position as to steel. The European countries had diverted nearly their entire steel output to the prosecution of the war, but the output of all belligerents was materially less than the present output of the United States, even though the latter is somewhat restricted as compared with its capacity. Thus the United States can prosecute the war vigorously and still have much steel left.

Germany and Austria have had no occasion to increase their steel output by new construction as they have had capacity in occupied territory to draw upon. France has added but little. England has added, perhaps, 3,000,000 tons to her ingot capacity. The United States, now has an ingot capacity of 50,000,000 tons or more, and is producing at the rate of 45,000,000 tons, against an output in 1913 of 31,300,000 tons from a capacity of 35,000,000 tons or thereabouts. With about 3,000,000 tons of new capacity in the United States in prospect of early completion, the world will have on its hands after the war an annual capacity of about 100,000,000 tons in steel ingots and castings, against a production of 75,500,000 tons before the war. About 18,000,000 tons of this will be in new furnaces in the United States and about 3,000,000 tons in new capacity

in England. The balance is largely represented by the amount by which the production of the United States fell below its possibilities. All these figures are necessarily approximations, and no allowance is made for countries other than the United States having operated at less than capacity in former years of peak production.

It becomes clear, however, that the consumption of steel after the war must be approximately one-third greater than it was before the war in order to engage the present plants, and it is equally clear that the United States is much more interested in this fact than is any other country, for it is the United States that will have to find nearly all of the increase in outlet.

It is fortunate that steel is an article that is employed rather than consumed. The demand rests to an extent, of course, upon the general activity of the people, but in much larger degree it rests upon the inclination of capital to seek employment in undertakings which in the main have an element of risk in them. It is for this reason that the demand for steel, particularly in the United States, fluctuates so widely. The annual "consumption," or more properly speaking "absorption," has reached as much as 600 pounds per capita. Nowhere else has the proportion been anything like so large.

The war is being waged to make the world safe for democracy. It will then also be safe for capital. Such was not the case before the war. For years previous, every time there was a depression in the world's business one of the causes assigned was the fear of Europe becoming embroiled in a war. Even with no distinct prospect of war there were many regions in which it was altogether unsafe to invest capital even though the promised returns, safety being granted, were very large.

One can rest assured that after the war, in the new and better world it thrills us to think we are making sacrifices to create, there will be almost unbounded opportunity to employ steel in new ways. In addition to this there will be much steel required for reconstruction. It is a question of whether capital can be found for the work, but in the last analysis what is commonly known as "capital" is not a fixed thing. It is largely the creation of confidence, and confidence begets credit, which is closely akin to capital. In the new order of things everyone will work and will work hard. The world will have learned more of how to do things and do them quick, for the war has taught much with respect to construction work.

The United States can do either of two things. It can isolate itself with a tariff wall as it did after the Civil War, or it can employ scientific tariffs designed to encourage imports of things we need and encourage exports of things we can spare. Adopting the latter alternative it must undertake to finance, even in some cases to operate, many of the projects upon which it must depend for an outlet for a part of its increased steel production. The domestic consumption may also be expected to be materially larger than at any time previous to the war.



## Petroleum

In an interview with Mr. A. C. Bedford, President of the Standard Oil Company of New Jersey, on September 12, Mr. Bedford said:

Before the war the demand for petroleum products was rapidly growing. It led to the prediction that the era of coal was giving way to the era of oil. Inventive and scientific genius had discovered many uses for crude oil derivatives with the result that the world was beginning to realize the economic value and diverse uses of petroleum.

Take gasoline, for example. It long had been a product which was regarded as of little value. Then came the invention of the internal combustion engines and its adaptation to the automobile. How the automobile has increasingly called for gasoline is shown by the fact that in 1899 there were 10,000 cars and in 1905, 85,000 cars. Then the numbers jumped rapidly, as, for instance, from 1,253,875 cars in 1914 to approximately 3,500,000 on the first of July of this year. The production of gasoline likewise jumped from over 6,000,000 barrels in 1899 to about 45,000,000 barrels in 1916. Thus the invention of the internal combustion engine greatly changed the problems of oil refining, for gasoline has now become one of the most desirable of crude oil products.

With this increasing demand for gasoline and other products, there developed an increasing call for crude oil for refining purposes. The total consumption of crude oil in 1904 was 117,000,000 barrels and it rose steadily to 324,375,503 barrels in 1916. Up until a few years ago, however, consumption by no means followed closely on the heels of the total production. Here are figures that show how the demand for crude oil has become greater than the available supply in this country:

Total U. S. Crude Production	Total Consumption of U. S. Crude
1914...301,527,000 bbls.	1914...265,762,535 bbls.
1915...302,989,533 bbls.	1915...281,104,104 bbls.
1916...308,272,519 bbls.	1916...324,375,503 bbls.

These figures represent "marketed production," i.e., the amount of crude recorded as passing through the pipe lines last year (300,767,158 barrels), plus the amount withdrawn from storage, i.e., from supplies previously stored in the field (23,608,345). In addition to these figures, almost 23,000,000 barrels of Mexican crude were imported and consumed in 1916, and over 16,000,000 barrels in the first six months of this year. There are not available to-day tank steamers enough to bring any material increase in these importations.

The latest figures taken from published sources of information for 1916 production, 308,272,519 barrels, prove somewhat better than the earlier estimates, and during the present year, from figures available for the first six months, the U. S. production of crude was on the basis of about 312,000,000 barrels annually.

But the consumption has been going on at the rate of approximately 330,000,000 barrels for the year. The supplies of crude oil in field storage and with the pipe

line companies has consequently continued to decrease in spite of new production (of which more will be said later). The amount of petroleum stocks in storage has decreased from 174,370,500 barrels on January 1, to 164,590,942 barrels on July 1, a reduction of 9,779,558 barrels. This reduction, however, is largely in the crude stocks in California.

The war has added still further to this demand for oil production, coming as it did on top of the normal development of the automobile, the aeroplane, the naphtha launch, the farm engines, and the fuel-oil burning ships which already were making a big call upon the supply.

The necessity for oil supplies for the prosecution of the war has been a heavy drain upon the United States. This is due to the fact that the revolution in Mexico prevented the proper development of those fields. Then came the destruction of the Roumanian oil fields. The Allies have been calling for more and more oil products every year.

The export of gasoline in 1914 was \$4,193,853 barrels, which increased to 5,632,182 in 1915, and then to 7,120,000 last year. Now comes the United States government with increased demands for gasoline for submarine chasers, aeroplanes, trucks and tractors, and many other purposes. It is estimated that the demands for the present year for gasoline will amount to more than 50,000,000 barrels.

Refiners, with their capacity enlarged until to-day they are handling about 330,000,000 barrels of crude oil in the course of a year, have done much to meet this situation. They have employed the best scientists and the best experts, who have developed means of extracting more than the ordinary amount of gasoline from crude oil by the invention of methods for cracking the heavy oil and refining it into gasoline. Herein the refiners have proved of immense value to the country and to the Allies in prosecuting the war, because they have at the expenditure of much capital provided the means for turning out the needed gasoline.

Had it not been for the introduction of the cracking process, the supplies of gasoline would long ago have fallen short of the amounts that actually have been required and used.

Another way of increasing the supply of gasoline is by the extraction of it from casinghead gas and natural gas. This industry is being developed and this year approximately two and a half million barrels of gasoline will probably be produced from this source. It is likely that more will be produced next year.

The demand for gasoline next year probably will exceed 55,000,000 barrels. That means it is necessary to produce still more crude oil; and here is the grave situation.

Despite the fact that the prices of crude oil have almost been record-breaking, and, therefore, offered good inducements to the prospectors and owners of wells to drill wells and turn out as much oil as possible, the figures for the first half of 1917 show that the number of wells drilled were 10,564 with an initial production of 692,718 barrels. In the first half of 1916,



12,658 wells were developed with an initial production of 800,266 barrels.

Thus, even with what seemed to be alluring prices for crude oil, the new production this year was less than the corresponding period last year. There are several reasons for this. First, there has been an increasing scarcity of casing and drilling materials caused by the demands upon the steel and iron mills for war production and their inability to supply the oil well drillers. The price of tank steel has almost been prohibitive. Next, the price of labor in the oil fields has also greatly increased. There has not been the profit to the oil producers that the public has ordinarily supposed, because the high price of materials and labor has added tremendously to the producing cost.

A general survey of the situation leads to the conviction that in order to produce the amount of crude oil needed, it is necessary to encourage more drilling and to find new fields of oil. To do this, it is necessary to pay prices for crude oil that will provide a reasonable profit to offset the high prices now paid for labor and for drilling materials. It is necessary also to make arrangements so that there will be a supply of pipe and casing. If this is done, the oil situation will speedily adjust itself. The supplies of petroleum which old Mother Earth still holds hidden are almost incalculable, but they are there to be drawn on if the proper effort is made. And with the capacity of refineries already enlarged to meet the increased requirements, and improved methods of refining to insure the maximum extraction of gasoline from the crude, all that is needed is—to get out the crude.

### The Nitrate Supply Committee's Final Recommendations

The fixation of atmospheric nitrogen for the purpose of national defense has been the subject of extended and extensive official investigations during the past year. Section 124 ("nitrate supply") of the National Defense Act of Congress of June 3, 1916, authorized an investigation into the best, cheapest and most available means for the production of nitrates by water power or any other power that may be best and cheapest. To permit rapid action in backing up the conclusions reached in this investigation, Congress appropriated \$20,000,000. The scientific investigation was in the hands of technical committees appointed for this purpose; the collection of all possible further information was in the hands of the special agents.

One of these agents was Mr. Eysten Berg, who visited Europe and submitted a report. Another of these agents was Dr. Charles L. Parsons, Chief Chemist of the Bureau of Mines, Interior Department, who, in the course of his investigations, visited the noted plants of Italy, France, England, Norway, and Sweden during the fall of 1916, and was able to give in his reports a most valuable summary and comparison of recent progress and conditions in the nitrogen-fixation industry at home and abroad, elaborated by extensive statistics of a confidential nature.

The first committee of scientists and engineers was appointed at the request of the Secretary of War by the president of the National Academy of Sciences in co-operation with the American Chemical Society, and consisted of Arthur A. Noyes, chairman; L. H. Baekeland, Gano Dunn, Chas. H. Herty, W. K. Lewis, M. I. Pupin, Theo. W. Richards, Elihu Thompson and W. R. Whitney.

This committee was succeeded and its work continued by a new committee—the "Nitrate Supply Committee"—appointed by the Secretary of War, and constituted as follows: Chief of Ordnance William Crozier, U. S. A.; Chief of Ordnance Ralph Earle, U. S. N.; Chief of Engineers Wm. M. Black, U. S. A.; F. W. Brown, L. H. Baekeland, Gano Dunn, Chas. H. Herty, Wm. F. Hillebrand, Arthur A. Noyes, Chas. L. Parsons and W. R. Whitney.

Of the progress of the investigation very little was heard during the past year, until it became known some weeks ago that the final decision reached was to put to immediate use less than \$4,000,000 out of the total of the \$20,000,000 "nitrate supply appropriation" of Congress until further information was given out by the Secretary of War at the end of last month. He first gave the details of the conditions as to the work to be undertaken at once by the Government, and second, published several reports in abstract written by Dr. Charles L. Parsons, chief chemist of the Bureau of Mines, as special agent.

The principal feature of the final recommendations of the committee, as indicated by this statement, is the manifest conviction that under the conditions now existing in this country those nitrogen fixation processes are most suitable which require the least amount of power. For this reason the committee does not favor those processes which have assumed greatest commercial importance in Europe in connection with immense hydro-electric developments. This explains at once why less than one-fifth of the total \$20,000,000 appropriation of Congress is to be used up—there will be no large expensive water-power developments.

The final recommendations of the Nitrate Supply Committee are as follows: that out of the total available nitrate supply appropriation of \$20,000,000 a sum of \$3,000,000, be placed at the disposal of the War Department to be used in building a synthetic ammonia plant, employing the process of the General Chemical Company, and of a capacity of 60,000 pounds of ammonia per 24-hour day, the plant to be located in a region where land, water, coal, and sulfuric acid are cheaply available, where good transportation facilities exist, and where the proposed new powder plant of the Government can be properly located. In the opinion of this committee all of these conditions just enumerated are best fulfilled by a location in a southwest Virginia or contiguous region.

That out of the \$20,000,000 appropriation a further amount of \$600,000 be placed at the disposal of the War Department to be used in building a plant for the oxidation of ammonia to nitric acid and the concentration of nitric acid, of a capacity equivalent to 24,000 pounds of 100 per cent nitric acid in a 24-hour day, the plant to be located in the neighborhood of the synthetic ammonia plant and the proposed new powder plant of the Government.

That experimentation looking toward the industrial development of the Bucher process for the production of ammonia be at once proceeded with, and further that, contingent upon a satisfactory arrangement with the Nitrogen Products Company, a sum not to exceed \$200,000 be allotted for this purpose out of the \$20,000,000 nitrate supply appropriation.

That out of the \$20,000,000 nitrate supply appropriation, \$100,000 be made available for the active prosecution of investigations of processes for the industrial production of nitrogen compounds useful in the manufacture of explosives or fertilizers, and that these investigations be planned and supervised by the War Department.

That, in order to increase the production of ammonia and toluol, the Government promote the installation of by-product coke ovens by directing that priority be given in the production, delivery and transportation of the materials and parts needed in their construction.

That the decision as to more extensive installation of nitrogen fixation processes and water power development in connection with them, be postponed until the plants above recommended are in operation or until further need arises.

That the immediate accumulation and permanent maintenance of an ample reserve of Chile saltpeter not less than 500,000 tons is most urgently needed in this country.

The foregoing report having met with general approval, the Secretary of War directed the Chief of Ordnance of the Army to proceed to carry out the committee recommendations on the synthetic ammonia and nitric acid plants, and announced that for the present the consideration of development of large water-power installations which had been begun by the Inter-departmental Board (Secretaries Baker, Lane and Houston) appointed by the President would be suspended.

Pending actual developments, the Ordnance Department of the Army is proceeding as energetically as possible with the work intrusted to it, has made arrangements for taking over orders at cost which the General Chemical Company had placed for the necessary apparatus for the construction of a considerable plant for their own use, and thus gains considerable headway upon much of the apparatus as well as favorable prices. The J. G. White Engineering Corporation has been engaged for the remaining engineering work and the actual construction; the plans for apparatus are essentially complete, and designs for all of the buildings are very nearly completed as a result of work done by the engineers of the General Chemical Company.

One of the reports, dated Jan. 27, 1917, which Dr. Charles L. Parsons, chief chemist of the Bureau of Mines, prepared for General Crozier, gives interesting data on the arc process, the Haber process, the Cyanamide process, and by-product coke-oven ammonia.

Concerning the *arc process*, which is operated on a very large scale in Norway, it is said that in spite of the very low efficiency of the process, yet on account of the very cheap horsepower available in Norway and the fact that the raw materials cost nothing and are always at hand, nitric acid can there be produced by the arc process at a cost less than by any other commercial process.

The cost of horse power used for the production of nitric acid in Norway is less than \$5 per horse-power year. The best estimates in my possession indicate that with horse power at \$10 per horse-power year, the cost of finished strong nitric acid at the plant would be as cheap as by any other process now in operation. However, the low cost of producing nitric acid by the arc process is outweighed by so many other disadvantages that, in my opinion, the process is entirely inapplicable to the uses of the United States Government, and this opinion appears to be shared by all who have given careful thought to the subject. The cost of installing the arc process is high and it involves the use of an amount of horse power that seemingly is not available on the American continent within reach of the points where the nitric acid would have to be used.

Nitric acid is not economically transportable. As strong nitric acid it can be transported only if tank cars made of aluminium can be obtained, and aluminium is a metal that, for this purpose, has many disadvantages besides cost. The nitric acid might be transported mixed with sulfuric acid in iron tank cars, but this involves the erection of large sulfuric acid factories near to the nitric acid plant and a large addition in freight rates. Freight rates on such nitric acid as is transported are very high and must always remain high on account of the dangers involved.

The great difficulty that has faced the Norwegian plants from the beginning, namely, a market for their products, would in peace times be a serious obstacle to the operation of a large arc plant in the United States. An arc plant at its best involves the use of 2.33 horse-power years per ton of weak nitric acid. This means that a water power development of at least 50,000 horse power would be necessary for the peace requirements of the Government, and a development of 440,000 horse power would be required for war purposes. These figures are minimum figures on the basis of the relatively high efficiency reached in Norway. No installation should be considered by the Government of less than 75,000 horse power for peace requirements or 550,000 horse power for war requirements. If the arc process is to be used it would also be advisable to arrange for the production of explosives at the point where the arc plant was located. This would of course involve the transportation of all other raw materials needed, such as benzol, toluol, alcohol, acetone, glycerine, sulphuric acid, cotton, and other materials too numerous to mention, to the plant and the transportation of the finished explosives therefrom to the place of consumption. As these materials are highly combustible and for the most part carry high freight rates, it has been found necessary the world over to locate the plants intended for the production of munitions near to the point where the munitions are likely to be consumed.

Among the recommendations of this report is one for the reservation of a supply of platinum.

As platinum is an essential for the oxidation of ammonia and of the utmost importance in the production of sulfuric acid and other supplies required for munitions; as there are no platinum reserves in the United States save a small amount obtained in the electrolytic purification of copper, gold, and silver ores; and as platinum is one of the precious metals with a value above that of gold, I especially recommend that legislation be asked which will conserve the platinum obtained each year by the United States mints, putting it in the vaults if necessary and issuing treasury notes against it as in the case of gold. Platinum would then be available for immediate use in case of need for the



production of nitric acid by the oxidation of ammonia and for the production of sulfuric acid so important in case of war. This platinum would be available without cost to the government and could, if desired, be used as a reserve for circulation, because even if applied to the purposes above mentioned there would be comparatively little actual loss of the metal itself.

The construction of a hydroelectric plant is recommended only if the arc or cyanamid process is used.

I seriously doubt whether hydroelectric power will be necessary or desirable three years from now for the most efficient process of fixing nitrogen, and accordingly I deem it unwise to install such hydroelectric power at great cost with the sole purpose of producing nitrogen. If, however, such water power can be utilized by the Government in the production of certain ferro alloys absolutely essential for ordnance and other munitions; can be sold to commercial companies who will take upon themselves the financial risk involved in the erection of plants for nitrogen fixation, under guarantee of cheap ammonia to the Government; or can be sold during peace times to companies requiring power for purposes which would allow instant requisition of the power by the Government in time of war without handicapping the supplies of other needed war material, the development of such hydroelectric power would be highly desirable.

A second report by Dr. Charles L. Parsons (April 30, 1917) is particularly interesting, for the data it gives on the new synthetic ammonia process of the General Chemical Company.

The General Chemical Company, through the chairman of its board of directors, Dr. Wm. H. Nichols, has offered to the Government the use of the de Jahn process free from any charge or royalty for the purpose of explosive manufacture, while for fertilizer manufacture a royalty of \$5 per ton of 2000 lb. of fixed nitrogen in any form shall be charged. (This represents a charge of not more than 25 cents per ton for the usual mixed fertilizer.)

The de Jahn process has been developed in the past four years by the General Chemical Company for the synthetic production of ammonia by direct combination of hydrogen and nitrogen. Lower pressures are used in it than in the Haber process. It has been in successful operation on a large experimental scale with several small units for ammonia production, and with one unit larger than those supposed to be used in Germany with the Haber process. It is considered to be the least expensive and most easily installed of all processes investigated by the committee.

The General Chemical Company has also developed and brought to a commercial basis the production of a mixture of nitrogen and hydrogen from coke, air, and water, which will yield hydrogen at a cost lower than heretofore obtained in this country and probably lower than that obtained in Germany.

As to cost of construction and operation it is estimated that even under present conditions a 30-ton per day plant can be built for an expenditure of \$3,000,000 and can be operated at a cost of not to exceed 4 cents per pound of ammonia produced, allowing \$5 per ton of product for repairs and 12½ per cent of the cost of the plant for interest and depreciation. It is believed

that the charges for repairs, interest and depreciation are excessive, as, together, they comprise more than 50 per cent of the total cost of the ammonia production. In the estimate \$3 per ton of product is allowed for general expenses and overhead charges.

It is estimated that a smaller plant of at least 7½ tons per day capacity can be built at the present time for approximately \$1,100,000, including land and buildings. Such a plant would yield 2700 tons of ammonia per year—equivalent to 8700 tons of 96 per cent nitric acid, assuming 85 per cent recovery.

The following table gives comparative construction and operating costs of the various comparative processes:

	Arc	Cyanamid	Haber	General Chem. <sup>1</sup>
Product .....	35% HNO <sub>3</sub>	NH <sub>3</sub>	NH <sub>3</sub>	NH <sub>3</sub>
Power required .....	10.5	2.2	0.2	0.2
Investment .....	\$1,410 (a)	\$440 (a)	\$340	\$300
Operating costs <sup>2</sup> .....	170	150 (b)	119	97
Product .....	96% HNO <sub>3</sub>	96% HNO <sub>3</sub>	96% HNO <sub>3</sub>	96% HNO <sub>3</sub>
Power .....	10.8	2.3	0.3	0.3
Investment <sup>3</sup> .....	\$1,500	\$500	\$300	\$200
Operating costs <sup>4</sup> .....	220	270	239	217

With respect to the Bucher process, Dr. Parsons mentioned that this new process has been developed by Prof. J. E. Bucher (described in this journal, Vol. XVI, page 315, March 15, 1917). The fundamental idea is to produce ammonia through cyanide as an intermediate product. The process is owned by the Nitrogen Products Company, and is used on an experimental scale in two plants at Saltville, Va., in a coal-fired furnace, and at Niagara Falls, N. Y., in an electric furnace. The president of the Nitrogen Products Company, Mr. Edward E. Arnold, who six months ago declined to go on record as to the future of the process, now unequivocally states that he considers the process a certain commercial success and a probable competitor with any other process for the production of fixed nitrogen. This company has offered to the Government the use of the Bucher process under conditions like those tendered by the General Chemical Company.

For the change of the ammonia into nitric acid two types of processes are available: the Frank Caro process and the Ostwald-Barton process. A third promising possibility is the oxidation of ammonia or cyanamid direct to ammonium nitrate in solution.

The present commercial efficiency and output by the Ostwald-Barton process is higher than by any other concerning which exact figures have been obtained. It is higher than the published figures for the Frank Caro process, but as figures for that process have been published only on a minimum basis, it is impossible to state whether a high efficiency of conversion and capacity of catalyzer has been reached by that process.

<sup>1</sup>Estimates on General Chemical Company process are based on present wartime construction costs. All other on normal prices.

<sup>2</sup>Amortization for cyanamid as charged by operating companies. Amortization for Haber 20 per cent of plant cost for repairs, interest, depreciation. Amortization for Arc and Modified Haber 12½ per cent interest and depreciation. \$5 per ton of product for repairs.

<sup>3</sup>Except for Arc process, includes ammonia plant as given A, power additional, \$10; oxidation and absorption, \$140; concentration, \$40; steam plant, \$40.

<sup>4</sup>Except for Arc process, includes ammonia costs as given; oxidation, \$50; concentration, \$70. No allowance made for unoxidized ammonia.

(a) Power plant investment reckoned at \$100 per horsepower. (b) Cyanamid production, \$122; ammonia from cyanamid, \$28; total, \$150.



## The Colleges and Their Neighbor's Smoke

By Herman Schneider

Dean, College of Engineering, University of Cincinnati.

Davy Crockett was a great man, and he lived at the right time. He was a mighty individualist, and individualists were needed in his day. His favorite expression was said to be, "I'll move on as soon as I can see my neighbor's smoke!" And he did. By moving on, he and kindred spirits made it safe for us to settle down.

For settled down we are, with our neighbor's smoke all about us, and individualism a thing of vacation time only. We work together, talk together, progress together, or get out of the procession entirely. Even those super-individualists, the I. W. W., flock together.

The great man of this day is the one who can attune his powerful individuality to the hazily forming ideas and ideals of a hundred million individuals; the one who can think nationally, feel nationally, and act nationally; whose neighbor's smoke speaks of mutual interdependence and stirs the imagination to the nation-wide to-morrow of all of us, rather than to the arm's-length to-day of himself. Whether your work is in iron or ice or putty or prunes or eatables or education, the statement holds. It sounds oratorical, perhaps, but all big things sound oratorical on the first statement.

Living to-day is like reading an old-time thriller. You never know what is going to happen on the next page; generally it is the unexpected that does happen. Prophecy is permissible and pardonable only as a form of individualistic blow-off—heredity must be heard—but the safe working basis is to assume the big fact that hereafter we, the people of the United States, will work together like a Roman phalanx. There is no *or*, *but*, or *if* to this. It is in the minds of the people, and that settles it.

Just what form of phalanx we shall evolve no one can tell. But we do know that the plan will shape itself around the idea that in this land all things must *work together* for good—the good of all of us. If that sounds too altruistic to you, if your individualistic tendencies buck at it, there is just

one thing for you to do—get used to it. If you don't get used to it, if it doesn't become actually a part of your working organism, the phalanx will simply walk by you, perhaps over you.

In every line of activity the potential men who sense this notion to think nationally and to act nationally, will some day be the leaders in that activity. They will reach out to any smoke that has to do with their work, and coordinate all the fires into one intelligently working organism.

College professors love the word *autonomy*. Any daredevil who tries to monkey in a faculty meeting with the autonomy of the college departments is guilty of treasonable practices. So far as the colleges are concerned, the first difficult task to meet

the changing order will be the coordination of all the departments into a closely knit organization. Following that, or while it is under way, will come the great revolution: bringing the colleges actually, not on paper, into the mills, the government, the farms, the railroads, and more especially into the very difficult problems to be faced in all of these human affairs. For in the new plan of having all things and all persons working together for good, the colleges will have a mighty task to perform.

It will be their job to train nationally; their training ground will be where things are done, and their equipment all that has educational value.

The scientific problems will be many and difficult; but the problems of human relations will be more and doubly difficult.

To meet these in the new order, men must be trained at those places where *the problems actually exist*, and not where they have merely an academic interest.

This is the educational trend.

Davy Crockett is still paramount in some of our colleges, but you will see the day when the professor and his students and the producer and his fellow-workers will wonder how they got along without each other in their daily tasks. For we are at the dawning of a real democracy in which we shall think nationally, feel nationally and act nationally.

Cincinnati, Ohio.



*Herman Schneider*

## The Sulphuric Acid Situation

By Henry Howard

Chairman of the Executive Committee, Manufacturing Chemists Association of the United States.

There is probably no single article that is of more vital importance to the successful conduct of the war than sulphuric acid; without it, the manufacture of high explosives is impossible; without it the intensive production of food through the use of fertilizers also becomes impossible; large quantities are absorbed in the refining of petroleum, with the consequent production of gasoline and lubricating oils; and finally, it enters into the production processes of most chemicals whose applications in the arts and sciences are almost without limit.

Up to the beginning of the war, the sulphuric acid industry had had a steady and normal growth for many years, and the plant capacity was substantially in excess of the requirements of the country. The result was, that just before the declaration of war, many plants were not operating at anywhere near their full capacity. By April, 1915, this surplus capacity had practically all been absorbed, and three or four months later an acute shortage occurred which resulted in the construction of a large number of new plants.

The production of sulphuric acid is, of course, largely dependent upon the supply of the raw material, namely, pyrites or sulphur. A discussion of the sulphuric acid situation involves a consideration of our available supplies of these materials as much as of the available capacity.

Up to the beginning of the war, nearly all the sulphuric acid made in this country was made either from pyrites or from the gas recovered from smelting sulphide ores, the sulphur from Louisiana and Texas being almost exclusively absorbed in the paper mills for the manufacture of sulphite pulp. Nearly all the acid made from pyrites within a reasonable distance of the Atlantic seaboard was made from imported pyrites, principally of Spanish origin, so that any interruption in ocean traffic would be likely to cause serious embarrassment to the acid manufacturers of the Eastern United States.

Up to January, 1917, there was no great difficulty in obtaining all the Spanish pyrites required, but almost immediately after the opening of the unrestricted submarine campaign, it became exceedingly difficult, if not impossible, to ship Spanish pyrites to this country. These conditions would have brought about a desperate situation in this country had it not been for the Louisiana Sulphur Company and the Freeport Sulphur Com-

pany. These companies, at the request of the Chemical Committee of the Council for National Defense and acting in a most patriotic manner, have come to the rescue of the acid manufacturers by supplying huge quantities of sulphur at prices only slightly above the normal pre-war prices for sulphur. It must be remembered, however, that these prices, low as they are for pure sulphur at the present time, are nearly double what the acid maker was formerly paying for his sulphur in the form of pyrites. The production of sulphur from the wells of the Gulf States is, however, not capable of immediate or indefinite expansion, for it requires huge installations of high pressure steam boiler capacity. It is therefore impossible to expect a prompt and unlimited quantity of brimstone from these regions.

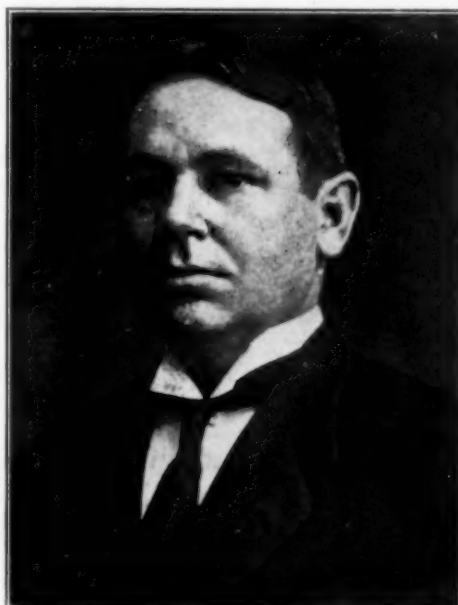
In the meantime, the Chemical Committee of the Council for National Defense, through Mr. A. D. Ledoux, chairman of the Committee on Pyrites, has been carrying on negotiations with the English Government regarding the resumption of shipments of Spanish pyrites. These negotiations are now bearing fruit and substantial tonnages have been coming forward during the months of July and August with a number of vessels already chartered for shipments to be made in September. The Institute of Mining Engineers is actively engaged in the exploration of domestic pyrite mines, and some increase in supply from this source may be expected.

In general, it looks as if the existing sulphuric acid plants would be able to get the amount of sulphur and pyrites necessary to maintain continuous operation

for the next six months or more, but at greatly increased prices. On the other hand, it would appear that the production of sulphuric acid will be inadequate to meet the demand during the balance of the war owing to the tremendous increase required for the production of fertilizers and explosives. Consequently, before next spring it will probably be necessary to arrange for the establishment of a preference committee to decide how the acid shall be distributed.

It has been estimated in Washington that the production of all grades of sulphuric acid, calculated as 50 deg. Bé., was 6,250,000 tons in 1916, and that requirements will be 8,000,000 tons in 1917.

Predictions of any sort, however, are very dangerous to make in these days because of complex conditions. For instance, if the transportation systems are deranged by pressing war demands, deliveries of phosphate rock will slow down. The increased demand of the fertilizer manufacturers for sulphuric acid then will not materialize.



*Henry Howard*

## The American Dyestuff Industry

By I. F. Stone

Vice-Pres., National Aniline & Chemical Co., Inc.

On the outbreak of the war there were but five American color producers, limited to the manufacture of the so-called "original" colors, direct dyeing cotton colors, and acid and chrome colors for wool and silk which they were able to manufacture successfully in competition with Europe. The chemical industry was then making full use of all the opportunities presented to it under normal conditions. They could not compete with the German manufacturers, first, because of the great advantage in capital, experience and everything that goes with a successful and enormous business; second, because it actually costs 44 per cent less in Germany to make colors than it does in the United States; and third, the domestic manufacturers are prohibited by law from making use of co-operative commercial devices such as pools, trusts, manufacturing and selling agreements such as are wholly lawful abroad and encouraged by their governments.

It may be interesting to briefly sketch a history of this industry from its first inception in this country. The first American aniline factories were established about 1875. By 1880 there were some ten factories engaged in the manufacture of these products, and it looked as though it would be a very successful industry. Unfortunately, however, in 1883 a new tariff law was passed, reducing the protection on colors to such an extent that the industry was no longer possible, and consequently most of the factories dropped out until there were only three engaged, carried on more or less by the ambition of their owners rather than at a profit. About 1898 another factory was established, and along about 1914 still another. Owing to the intense competition of the European manufacturers, especially the Germans, none of these factories were successful enough to make a complete line of colors, and were restricted to only a few which could be made to advantage in this country. Again, they were forced to rely entirely upon European manufacturers for their raw materials; in other words, the intermediates, and naturally the European manufacturers charged them such a price that they could not successfully compete with the finished colors of Europe, made from the same intermediate products purchased at a lower figure.

In 1914, therefore, the American firms were making hardly one-tenth of the domestic consumption, and that largely with imported intermediates. At the beginning of the war, it was of course impossible for the German

factories to ship their usual quantities because of the fact that the government had taken charge of all means of transportation for troop movements. After a couple of month's interruption, however, comparatively regular foreign color shipments of about 75 per cent of the normal sales arrived until the spring of 1915, when they ceased entirely. This was, I believe, partly due to the action of England taking measures to prevent such shipments, and partly because the Germans were disinclined to sell when they could not get needed supplies like cotton and foodstuffs in return. In the face of this famine, most consumers were forced into part-time operation at great loss to themselves and their employees, or into lines which required little or no dyestuffs or such colors of American manufacture as could be had. In some lines, for instance, the hosiery

and possibly the leather manufacturers, this can be done to quite a large extent, as they mostly use blacks and other dark colors which were manufactured comparatively largely here; that is, for hosiery, direct and sulphur blacks, and for leather, blacks, nigrosines and logwoods. These were made and could be obtained in the United States almost in the necessary quantities.

Unfortunately for the aniline makers, however, at the outbreak of hostilities an embargo was immediately placed upon intermediates, for reasons best known to the German government. These essential substances could not be previously produced profitably in America. Had it not been for a small and precarious local production of aniline oil and nitrobenzole, the American dye works would not have been able to con-

tinue. They immediately began making intermediates, as under those abnormal conditions it was not a question of price, but of ability to manufacture aniline dyes almost no matter at what cost, such was the demand. After some months a number of new concerns also started in business, chiefly making easily manufactured intermediates; before that time the established aniline works had expanded their regular products to such an extent that by the beginning of 1916 they were making about four times their former production of finished dyes.

As an illustration of the importance of the dyestuff industry in its relation to other American industries, it may be stated that the textile manufacturers, comprising their cotton, wool, carpet, knit goods, silk, cordage, shoddy dyeing and finishing branches, absolutely require a great quantity of dyes in their operations. Add to this the leather manufacturers and tanners, the paper manufacturers, the paint and color manufacturers, printing establishments, ink makers, shoe dressing man-



*I. F. Stone*



ufacturers and a hundred and one other lines which consume dyestuffs, and I think I could safely say there are upward of two million employees who are affected by any shortage in dyestuffs.

At the present time there are over 100 firms directly engaged in the manufacture of crudes, intermediates and colors, with a combined investment estimated at \$50,000,000, producing a quantity of finished dyes greatly exceeding in quantity the entire consumption during 1914. The American works, led by the old established factories, are now producing practically a full line of basic, acid, chrome and sulfur colors, and in the future will be able to produce enough to take care of the demand, if the consumers are careful enough to make forward contracts so that the factories can be prepared with the necessary installations and raw materials. They are willing to increase their facilities to practically any extent as long as customers will support them by making contracts. As to future expansion, there is no reason why any properly equipped chemical manufacturing company in the United States cannot supply the same quality and amount of colors as we were getting from Germany. We have the raw materials, we have the ability and the skilled labor.

Fortunately, Americans have become alive to the advantages of the by-product coke oven, and the construction of such ovens has recently gone on apace, and the local production of raw materials is now ample for all the demands of the dyestuff industry. For instance, we are already independent of Europe in benzol, which will always find a ready market for its surplus as a motor fuel. Ample benzol has made it possible to manufacture phenol (carboic acid) synthetically, which latter substance is produced in less proportion to the consumption than any of the chemicals occurring naturally in coal tar. Toluol is of more importance than benzol to the nation on account of its use in the explosive field rather than for its use in the manufacture of dyestuffs, and an increase in supplies in benzol brings increased supplies of toluol. More naphthalene and anthracene is being recovered and refined from the heavier portions of the distillate by a revision of the specifications for creosote oil, and no doubt more of these substances can be recovered by the by-product plants if the proper demand is assured at a price commensurate with the added investment and cost of manufacture.

German chemists probably have \$400,000,000 invested in the dye industry. They do not intend, if they can prevent it, that the color industry get a sound footing in the United States. I believe they will resort to the extreme of price-cutting and unfair methods to kill off any competition with their own export trade. In order that we may understand and properly provide for this contingency the following should be considered:

The materials of the dyestuff industry are used in the coal-tar explosives industry as well as for coal-tar medicinal. Each of these three industries co-operate with the others to make full use of these materials; alone none can fully make use thereof nor succeed; the correct and proper utilization of these materials re-

quires successful co-existence of all three industries in one and the same country.

It is further clear that the stability of a complete domestic chemical industry, in so far as it depends upon commerce, is bound up to a successful merchant marine and to an efficient foreign banking condition.

The color industry will require a plentiful supply of all chemicals, including the so-called heavy chemicals, all of which will, doubtless, be obtained from American sources.

It will also require quantities of all basic raw materials and intermediates derived from coal tar in practically chemical pure form. The war has greatly stimulated the manufacture of a number of these products, unfortunately mostly for use in explosives.

The manufacturers of intermediates and colors during the abnormal war conditions have been able to obtain an abnormal profit out of which they have built and paid for their factories. They are now therefore in the same financial position as the German factories.

The United States Government has finally discovered that in order to make this industry permanent it is necessary to give more adequate tariff protection, and a tariff bill passed in 1916 giving this additional protection allows the American manufacturers a very much better opportunity.

The American consumers have realized the importance of having an aniline industry in this country, and therefore they will undoubtedly give the preference to American-made products.

A first step toward the mobilization of all the factors of this situation has been taken by the amalgamation of several old-established concerns into one large company which will now be in a position to centralize productive effort and capital in all the steps from the mining of the coal, through the by-product plants, intermediate and chemical manufacturing, to color making, selling, and research.

To sum up briefly the whole question of the permanency of the American dyestuff industry, it is apparent from the above that with united factories capable of producing the necessary colors, an adequate tariff, a strong financial condition established during the war, and the preference of American consumers for American products, we have certainly insured the permanency of the American dyestuff industry.

The high prices charged by American manufacturers of colors are due to, first, the demands of the explosives industry, which uses the same raw materials, and second, the high rates of wages paid by the industry. Products will revert toward their normal levels when these other matters reach normal conditions. It is very difficult to say whether labor charges will ever revert to their pre-war basis, as the laboring people have been educated to a higher schedule of living, and it is doubtful if conditions will change much in this respect. I believe, however, that American consumers will be only too glad to pay labor everything it is worth, and consequently a higher price for colors than ruled before the war will be cheerfully paid by our consumers, if they are within reason, which they will be.

New York City

## Electric Furnaces

By Francis A. J. FitzGerald,

Consulting Engineer

Past-President, American Electrochemical Society

Although electrometallurgical furnace plants were increasing before the Great War the increase was not as rapid as it should have been. The increased production of electric steel showed that this development was slowly approaching the point it should have reached, but it was still relatively if not absolutely below the European level. The United States Steel Corporation had built a large Héroult furnace in its South Chicago plant, and had made a variety of products therein, but the expectations of many that a great number of these furnaces would be constructed were disappointed.

Since the war began, however, there has been an extraordinary increase in electric steel furnaces. Probably this would be even greater than it has been were it not for the difficulty of getting electrical equipment in reasonable time and also to the shortage of carbon electrodes.

The difficulty of getting an adequate supply of electrodes and reasonably prompt delivery is a good measure of the extraordinary increase in electrometallurgical plants. Before 1914 there was no difficulty whatever in getting an adequate supply of both amorphous and graphitized electrodes. Many standard sizes could be obtained immediately from stock supplies and any standard size could be obtained in quantity in six weeks' to two months' time; but at the present time electrometallurgical processes requiring amorphous electrodes are limited by the electrode shortage. The question of electric power, serious as it is, is not of the same nature as that of electrodes. The power question is largely one of price, and consequently on account of the enormously increased prices of electrometallurgical products it is now possible to pay power rates that would have been considered ridiculous before the war. In the case of electrodes, however, it is at present impossible to obtain prompt deliveries at any price.

It is a matter for regret, so far as steel is concerned, that there has not been a development of the use of the induction furnace or the Röchling-Rodenhauser modification in this country. Furnaces of this kind are used very largely in Europe and are of course independent of the electrode supply. On the other hand, it is possible that even if we had a number of these in use the shortage of magnesite would be troublesome.

One result of the war as regards electric steel-making seems to be pretty certain; no sane person will construct a crucible steel furnace plant hereafter.

The pendulum is swinging from crucible steel toward electric steel, due to similar economic conditions which recently caused the culmination of Bessemer capacity.

The shortage in the graphite supply and in the German clays used in making crucibles, with the resulting poor quality and high price of crucibles has stimulated greatly the desire for a good electrically-heated brass melting furnace. So far as bronze and copper is concerned there seems to be a satisfactory solution in sight, some good reports have been made on the use of the Rennerfelt furnace for this work. But the melting of brass still presents a difficult problem. The successful use of any form of arc radiation furnace for this purpose seems doubtful, and we must wait to see what can be done as a result of Clamer's and Hering's work on induction and pinch effect furnaces, or of Gillett's experiments.

The ferro-alloy development has been astonishing and everyone seems to be rushing into the manufacture of ferrosilicon as a result of the sensational prices that have been quoted for that material. High prices have undoubtedly resulted in turning over the use of a good deal of furnace capacity hitherto used for calcium carbide manufacture to the production of this material.

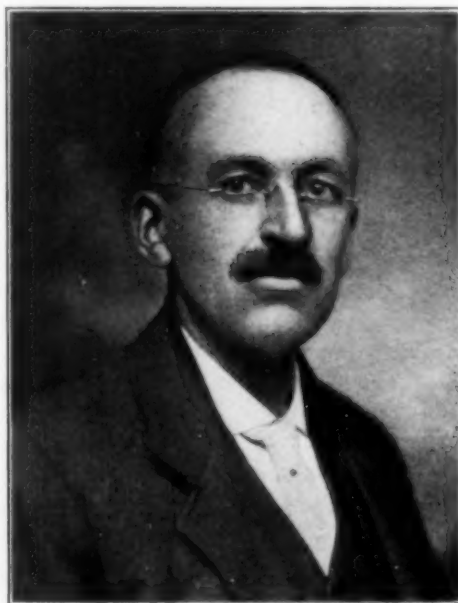
Another most interesting development is the manufacture of ferromanganese in the electric furnace. This has often been considered in previous years, but the low price of 80 per cent ferromanganese has formerly made its electric production unattractive. Now, however, things are very different and this has stimulated the electric furnace method in a wonderful manner.

Another new and interesting development is the production of basic pig iron in the electric furnace using high-grade steel scrap as a raw material.

The increase in furnace capacity for the production of artificial abrasives has been enormous. This is, of course, largely due to the increased demand, but also to the cutting off of the supply of Naxos emery. The consequence is that electric furnaces making aluminous abrasives and carborundum, which produced 62 per cent of the total abrasives used in the United States in 1914, have further experienced a great increase in number and output.

Americans may well feel proud of the way in which their manufacturers have met this situation, but at the same time it is with bitter regret they see in this case the continued exile of this distinctly American development to foreign countries, caused by the folly of the Washington politicians in the matter of water power legislation.

Niagara Falls, N. Y.



*Francis A. J. FitzGerald*

## Aluminium

By Jos. W. Richards

To write anything satisfactorily upon the past, present and future of aluminium in a few words is not an easy task. Most readers of this journal are familiar with the beginnings of the industry, about the time of the invention of the Bessemer process, the middle of the last century. But the great hopes of Deville were never realized, the infant industry in France remaining an infant for twenty-five years. The industry began to grow into a promising youth in 1890, with the rise of the Hall process, and reached manhood strength and development only with the beginning of this century. The center of the industry has moved from France to North America, and of the nearly 100,000 tons produced annually, the United States figures for approximately two-thirds.

The sources of raw material, bauxite, have not changed much in many years. France has the largest deposits, and really still exerts a controlling influence upon the industry in Europe from her command of the raw material. Purification of the raw material is essentially a manufacturing chemical operation, and has developed largely in the United States, Great Britain, France, Belgium and Germany.

Reduction of purified alumina to metal is an electrolytic operation, requiring large amounts of cheap power. In this matter, countries like Canada, Norway and the Alps possess great advantages, and the final step of reduction gravitates toward these countries. Norway in Europe, and Canada in America, loom up as the future centers of aluminium production, but are dependent upon other countries for their supply of the raw materials. Most of the large companies are therefore international in scope, working the mines in one country, purifying the raw material in another, and producing the metal in still another.

As a war material, aluminium finds many uses. Aluminium time fuses for shrapnel are used in place of brass, several million having been put into shells made in the United States for the Russian Government. Several thousand tons of aluminium wire have been used in the point of the modern long-tapered rifle bullets—the copper-nickel sheath has a small pellet of aluminium inserted in its point, the remainder being filled with lead. This gives a flatter trajectory and increased accuracy of fire. Machine guns of the air-cooled type use aluminium radiators. The explosive "ammonal," consisting of powdered aluminium and ammonium nitrate, is being

used in large quantities by all combatants in the present war. Aerial construction has absorbed large quantities of aluminium. Each large Zeppelin contains about 9 tons of aluminium framework.

There is no longer any question of the status of aluminium as an "every-day" metal. Its use for cooking utensils has made it a household friend, and this still figures as its largest potential use. In automobiles it is a necessity, and almost one-third of all that is made is thus consumed. It is now a common, useful servant of mankind in a thousand ways undreamed of twenty-five years ago. Its introduction into common use has been one of the great achievements of the nineteenth century.

Since the outbreak of the war it has become increasingly difficult to get statistics of any reliability concerning the course of the aluminium industry. Even the promoters of the industry in America profess ignorance regarding the development of the industry in Europe.

It can be assumed with considerable confidence, however, that the industry has prospered greatly and increased in output except in Switzerland and Austria. In these countries, the producing company is controlled by German capital and a larger part of the product was shipped to Germany, while the alumina consumed was obtained mostly from the bauxite deposits of the south of France. This source of supply of alumina has naturally been cut off by France, leaving the Central Empires dependent upon their own sources of alumina. The industry in the



*Jos. W. Richards.*

United States has meanwhile developed handsomely.

It is important to note that while recent quotations were 55 to 65 cents per pound for odd lots, during 1916 the Aluminum Company of America supplied the bulk of the domestic consumption at 27 to 33 cents per pound. This was in consonance with a policy to supply the old customers at the same rates as prevailed in 1915, unaffected by the European demand. The Aluminum Company of America deserves great commendation for the combination of good business sense and intelligent patriotism shown in thus sparing the consumers of aluminium in this country the great hardships which a narrower business policy might have imposed.

What of its future? Its use and its usefulness will continue their rapid rate of increase; it will become cheaper after the war, and will rank with the half dozen metals most useful to mankind. The present output of 100,000 tons yearly will reach 1,000,000 tons before the middle of the century, and in net usefulness to mankind it will stand beside copper and be surpassed only by iron and steel.



## Electrochemistry

By A. H. Hooker

Technical Director, Hooker Electrochemical Company

The present war has emphasized the close relationship of chemistry to the ordinary necessities, comforts and luxuries of life, to say nothing of their vital importance in the materials of war, whether these materials be motor trucks, hospital supplies, guns, bullets or explosives.

The importance of the Niagara Falls industries to the present needs of our country, the calamities which might result from any curtailment of the power used by these industries, and the general public good which could result from a greater conservative use of this power, is best illustrated by a consideration of the uses made of some of the products so produced.

Phosphorus and phosphorus compounds are essential components in every match, the highest grades of bronze and copper alloys, in fire-carrying anti-aircraft bullets, and in liquid fire. Chlorate is equally important in the manufacture of matches and the fulminate cap, without which not a mine, cannon or rifle can be discharged.

Calcium carbide produces the acetylene gas for lighting the isolated country home, the small village and the automobile, as well as for flares, buoys and headlights. The cutting of armor plate, the building of our ships and steel structures, the repair of war's wastage requires the oxy-acetylene flame.

Carborundum, alundum and other electric furnace artificial abrasives are of the utmost importance in all the metal working industries. Without these the manufacture of motor cars, rifles, all kinds of machinery and equipment would be curtailed tremendously, and the expense of manufacture increased many fold.

Sodium is the basis for the production of cyanide, upon which depends the extraction of a large part of our gold and silver from the ore. Sodium peroxide is the starting point for hydrogen peroxide bleaching agents and disinfectants, and the source of oxygen for rescue helmets and hospital aid. That Chloroform is a necessity in surgery needs no argument.

Artificial graphite as electrode material is absolutely indispensable to the industries producing caustic soda, chlorine, and in the refining of steel. Every time a flash light gleams, a self-starter operates, or a telephone call is answered, think of the artificial graphite in the battery which makes it possible. As a lubricant defloculated graphite fills a field which cannot be taken by any other material.

Caustic soda is essential for the manufacture of soap, the refining of petroleum and the production of gasoline. As a strictly war material it is required for the manufacture of nearly all explosives as a neutralizing and fusing agent. It is equally important in the production of synthetic dyes and medicines.

Chlorine is a many sided substance, beneficent and devilish in turn. As a sterilizing agent it purifies the drinking water of our cities and camps, preventing typhoid and other water-borne diseases. It is the basis of the Carrel-Dakin solution, that wonderful antiseptic dressing used on the battlefield. As a poison gas, we all know of its fiendish effects upon the soldiers in the trenches. Combined with calcium it forms bleach without which our paper mills and printing establishments would be bare of book and writing papers; it is also necessary in bleaching cotton fabrics. Chlorine, combined with such coal tar products as benzol, toluol and naphthalene, plays a most important part in our rapidly developing dye and explosive industry. As an example of this, we combine chlorine with benzol to produce monochlorbenzol. This on nitration and treatment with a caustic alkali becomes dinitrophenol, the intermediate from which may be made one of our most important and fastest dyes, sulphur black, or else by further nitration, converted into picric acid, one of the most largely used explosives.

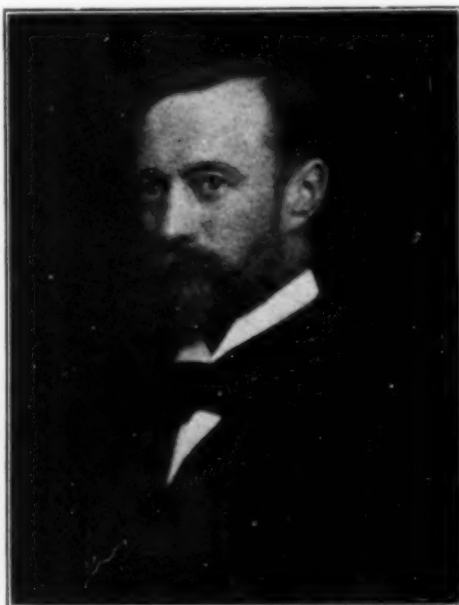
This vital electrochemical industry, which now has its great center in Niagara Falls, is seriously threatened in its present development by the withdrawal

of power which has been imported from Canada. The farther development of the industry, which is so widespread in its benefits to the entire population of the country, has been arrested or sent to foreign lands, all through lack of prompt conservation and conservative development of the power which is going to waste at our door.

A large increase in our present power development is beyond question possible without a particle of injury to the scenic beauty of the Falls. This development and the growth of these industries would be of untold benefit to the nation at large, and is of particular significance at the present time when we consider the vital importance of these materials to the successful carrying out of this war, and the conservation of coal and transportation.

It would seem that now, if ever, was the proper time to consider an increased power development and the proper means of obtaining the maximum development without injury.

Niagara Falls, N. Y.



*A. H. Hooker*

## Western Sulphuric Acid

By Lewis B. Skinner

Vice-President Western Chemical Company.

In these days of acute sulphuric acid shortage, the present and possible production of sulphuric acid in the Western States becomes an interesting phase of the national situation.

The volume of pre-war by-product acid was in part dependent upon the American spelter market—the foreign metal market was so well supplied from German-controlled works in Belgium operating on Australian ores that exportation was small. Again, freight rates make it practically impossible under normal price levels to transport either acid or ore any great distance by rail to the Eastern and Southern States, where the acid finds a ready market.

The blende roasting plants are located in the Middle Western areas, where are large supplies of cheap coal and natural gas. The available zinc ores come mainly from west of the Mississippi and Tennessee, and freight rates have determined the economic location of the smelting plants near cheap fuel, largely in Illinois.

Just previous to war times there was an invasion by the Middle West acid-makers into the peak-price sulphuric acid area of Pennsylvania.

Since the war begun, two more large zinc acid plants have been completed in the Pittsburgh district. One of the operators, the United States Steel Corporation, had formerly absorbed a very large amount of acid from other makers. Ores from Australia failing to reach Belgium are finding a very satisfactory market at these Pittsburgh plants, and it would seem as if freight rates are such as to allow of a continuation of this ore movement even in normal times.

So much pressure had been brought to bear upon copper companies in Tennessee by the United States forestry officials that the smelters, several years before war times, had made a decision to manufacture acid with their sulphur smoke. The daily American production of 60 deg. Bé. acid had been increased some 1000 tons by these installations, which by the way were made possible only because their plants were operating semipyrritic blast furnaces on pure ores, and in a region of large acid consumption.

Preceding the war, the demands of the Pacific Coast were not very large, probably no greater than a total of 150 tons of 66 deg. Bé. per day, and that of the Rocky Mountain area farther eastward no greater than 50 tons. Such a limited quantity was easily supplied by

local acid plants operating with sulphide ores mined primarily for their metal content, and whose metallurgical treatment demanded a preliminary roasting or calcining operation.

Two large plants have recently been completed by two of the leading smelting companies in the Rocky Mountains. One plant at Anaconda, Mont., is expected to fill needs created by a new metallurgical process, and the other, near Salt Lake City, is expected to furnish acid for leaching oxidized copper ores. A third plant is being built by another smelter in Arizona. The Rocky Mountain area is therefore receiving its share of attention.

On the declaration of war, acid makers expected a greatly diminished demand, especially from the fertilizer maker, who would curtail his operation since he could get no more German potash. There was therefore much surprise when the spring of 1915 found depleted stocks and an ever-expanding market. Spurred on by this condition almost every manufacturer has increased his producing ability by various refinements in process and other expedients, until to-day I estimate there is a legitimate plant increase of 50 per cent over that at the beginning of 1915.

Every acid maker is wondering what he will do with his plant production after the war is over. Sulphuric acid is not a commodity like brick, lumber or slabs of zinc, that may be stored on the prairie without deterioration until some change of commercial conditions makes its purchase desirable. A number of

small Southern plants which have been resuscitated by their neighboring fertilizer plants will doubtless again drop out of sight when the demand slacks off. The larger concern, with its interlacing of other operations and dependency on other commodities, will probably find it impossible to adjust itself so quickly.

I find it difficult to refrain from the idea that the American policy of preventing any "getting together" of those engaged in similar lines of endeavor is a poor one. How much better from the political economy point of view would it be could those unfavorably situated and operated plants be stopped when they cease to have warrant for existence, and be reimbursed for their losses, thus leaving those more fortunately circumstanced to furnish the market requirements. Instead, all will try to peg along to the last, and be subjected to the purchasing agents' game of playing one against the other, with the result that the time will again come when the dollar invested in this industry (as has heretofore been indicated by statistics) shall see less return than if it were engaged in any other normal activity.



Lewis B. Skinner

## Tungsten, the Key Metal

By COLIN G. FINK, Ph.D.

President, American Electrochemical Society

The various fortunes of war are fickle, and it is a truism to say that victory finally perches upon the pennons of that side having the greatest resources of brains, men, and munitions. Since prehistoric times, however, there has been an unending struggle between various races of mankind, and in this has been a continual development of weapons and defensive armor.

Considering even the stone age, that tribe of men who had easiest access to the best deposit of flint and the necessary skill to work it was evidently easily victorious over its neighbors who had to rely upon the softer bone or horn weapons. Even the best development of flint swords and daggers and spears and arrow heads was unable to repel the invasion of another race armed with bronze side arms and shields. Yet the bronze age passed after centuries of groping metallurgy, while the ancient smith produced steel in his primitive forge and discovered how to harden it after being cunningly wrought.

The success of the disciplined Greek and Roman armies over the barbarian hordes was certainly due to their key metal, iron or steel, which tipped their javelins, ribbed their shields and formed their short blunt swords. Against such equipment of men and munitions the flights of savage flints and missiles were impotent. The middle ages witnessed the gradual perfection of the ancient war harness, culminating in the knight, armed "cap-a-pie," who now rides clanking through the pages of the story book.

Lead then became the key material, and the foot soldier came back into his own. The patriots of 1776 who tore down the leaden statue of King George tempered their patriotism with thrift, and sent the image back to its donors piecemeal in bullets.

A century later metallurgy again changed the equipment of armies upon the invention of the percussion cap, a capsule of copper held the fate of nations.

Most of the elements of the modern breechloading and magazine rifle were known at an early period, but they remained undeveloped for lack of means to do minutely accurate work. Tool development is a parallel phenomenon. Some essential properties of tungsten steels have been known for over fifty years—self-hardening steel tools were invented by Robert Mushet between 1860 and 1870. Not until the Paris Exposition of 1900, however, did the modern era in tool steel begin; then Taylor first exhibited to the astonished

gaze of incredulous machinists the spectacle of a tool cutting so fast and deep that it delivered chips at a blue heat and in amazing quantities. Since that time the introduction of modern scientific shop management has been going on apace, wholly made possible by the use of these high-speed tools cutting four times as much metal as the best of the older carbon steels. Whereas in the wars of the past copper, tin and lead were, next to steel, the most important "martial metals," to-day tungsten alloyed as high-speed steel is the dominating factor. To deprive a nation of tungsten is to cripple its military power in time of war, and its industrial power in time of peace. Without high-speed steels, machine tools could not be produced nor operated in sufficient quantity to make the "seventy-five" and its thousands of shells, the rifle and machine gun and its millions of cartridges, nor could automobiles, farm machinery, ships or engines be replenished after the sword has been happily sheathed.

Germany was the only nation which properly appraised this situation in 1914. At that time, with characteristic thoroughness, she had a practical monopoly on the world's tungsten production. The mines of Burma, the world's most productive region, although in English territory, were controlled and operated by Germans and the ore shipped to Germany for treatment. The Cornish tungsten ore actually produced on the "tight little isle" was shipped to Germany for refining and then sold back to England.

At the outbreak of the war tungsten output actually declined as the German-controlled mines

stopped producing, and it was not until the middle of 1915, after a year's hostilities, that England finally awoke to the importance of the situation by noting that no more tools were to be had.

Then occurred a violent speculative rise in price accompanying insistent demands of the war boards for more materials. When England at last realizes the need of a thing she goes after it, and the result to-day is that out of a total of 19,000 metric tons of tungsten concentrates (60 per cent WO<sub>3</sub>) produced in 1916, England controlled and acquired 13,000 tons, or over two-thirds of the world's supply. Fortunately, the United States produced nearly 7000 tons of the best and purest of these concentrates in 1916, which is an earnest of our own possibilities—but it is important that these matters be well borne in mind and provided for against the time of necessity.

It may some day well be said that tungsten made democracy possible.

East Orange, N. J.



*Colin G. Fink*



## The By-Product Coke Oven

When, eight years ago, the Steel Corporation's new by-product ovens at Joliet, Ill., produced coke which made more iron per ton than standard Connellsville bee-hive coke, the doom of the wasteful bee-hive oven was sealed. Since that time, the advance of by-product coking has been a question merely of promoting a realization of relative coke values and of financing the relatively large plant investment required.

The outstanding feature of by-product coking development since the beginning of the war has been the confidence which American capital has manifested in advancing the tremendous outlay for permanent plant and equipment. With prices of all equipment soaring to undreamed-of levels, the complete plant costs twice or three times as much per oven as it cost five years ago, yet capital has shown no hesitancy. More by-product coking capacity has been installed or contracted for in the last three years than had been built in the twenty preceding years; the same capacity in bee-hive ovens would have required little more than one-quarter the outlay. Without an abounding faith in the value of by-product coke and in a lasting market for by-products, such a development would have been impossible.

By-product coking has doubled its capacity in the last three years. At the close of 1914 there was a capacity in by-product ovens for 15,000,000 tons of coke annually. Early in the year 1918, if present construction under way is carried to completion, there will be a capacity to produce 30,500,000 tons of coke per year. During these three years, 4037 ovens have been built or contracted for; their coal carbonizing capacity amounts to at least 23,500,000 tons per year, and the plant investment required has been over \$100,000,000.

Notwithstanding this rapid development the United States will still be making in 1918 about half of her coke in bee-hive ovens, with entire waste of by-products. In 1914 the by-product ovens produced 32.5 per cent of the total coke, in 1915, 33.8 per cent, in 1916, 34.9 per cent and in 1917 probably about 40 per cent.

Of all the coal consumed in this country scarcely 7 per cent is carbonized with by-product recovery, while in Germany the corresponding figure is greater than 30 per cent. Germany wastes no by-products, and, due in part to that fact, she was better prepared for war in August, 1914, than any other nation.

American coke oven practice uses larger units than European. The rate of coking is also faster by virtue of high temperatures permitted by the use of silica brick. The American capacity per unit and cost per ton is thus much better. There has been a tendency however in recent years to limit the width to a balance between the most advantageous coking capacity and the wall-temperature required for good by-product yields.

America's opportunity for growth in coal by-products recovery, and in chemical industry based thereon, is greater than that of any other country. Our requirements of coke for iron production and our consumption of anthracite in house heating far exceed those of any other nation. As anthracite fails, domestic coke will

replace it. By-product coke production therefore should not stop growing when the full demands of iron manufacture shall have been met.

Bee-hive coking, furthermore, will not necessarily be retained in any important degree in order to take care of fluctuation in the iron industry. The by-product coke plants can meet fluctuations in demand by varying their coking period and thus their rate of output. An excess of coke output also can be stored or disposed of at moderate prices for outside fuel purposes, in order to avoid shutdowns and consequent loss of gas and by-products. In this adaptability to steady operation with minimum labor and upkeep costs, and in the reliability and regularity of its output, lies much of the secret of success of the by-product coke oven.

The war has created an immense demand for toluol and benzol—the raw materials for the modern high explosives tri-nitro-toluol and picric acid. From a production of possibly 7,500,000 gal. of light oil in 1914, made at a dozen by-product coke plants operated by one company, the output has grown to approximately 60,000,000 gal. in three years—and all of the fifty-two by-product coke plants now operating in this country, with one exception, are equipped for recovery of benzol. Nearly 10,000,000 gal. of toluol per year are being made from this coke oven light oil.

Dyes and drugs, dependent on benzol, toluol, and coal tar crudes for their manufacture, require less than 10 per cent of the present light oil output, and are not likely to require more than that in this country for a number of years. When the war is over and the great demand for military high explosives has abated, benzol and toluol will find their outlet largely in motor fuel. Benzol containing 10 per cent toluol to lower its freezing point, is an excellent motor spirit, tried and proven, equal or superior to gasoline. With investment costs largely wiped out by war profits, benzol recovery plants can operate at a profit on gasoline prices.

Ammonia, in spite of a 100 per cent increase in production in three years, has maintained a rate of price advance commensurate with that of other commodities devoted to peacetime uses. The demand it enjoys for use in fertilizers, in the chemical industries, and in safety explosives is constantly increasing—faster than the supply can meet it.

In view of the almost unlimited field for the use of by-product gas, the rapidly widening application of coal tar and its products, and the prospect for the finding of new uses to absorb the present surplus of pitch and naphthalene—there can be no question of the disposal of by-products from the rapidly expanding industry.

Although the war has brought very large increases in the demand and price for certain by-products, this has not been the main factor in the recent remarkable growth of by-product coking. War profits alone, with their uncertainty of duration, could not justify the great investment in these large permanent plants. Rather has it been the confidence in the permanent value of the plants and their products, and the great influence of an abundance of available capital, supplied by the prosperity of the American nation.

## Readers' Views and Comments

### A Reply to the Criticism of the Chemical Exposition To the Editor of Metallurgical & Chemical Engineering

Sir:—In his letter to the editor of METALLURGICAL AND CHEMICAL ENGINEERING, published on page 206, Sept. 1 issue, Mr. G. A. Roush apparently charges that because three exhibitors in the Second Exposition of Chemical Industries neglected to supply information or material requested, that the entire exposition was a failure. Such a statement is unjustified.

Mr. Roush has failed to appreciate the larger purposes of the exposition to show the progress made in the industries it represents, to indicate where progress can be made, how through efficient equipment and materials production can be increased or costs reduced, to show where and what opportunities await development, and how our natural resources can be made valuable and useful.

An exposition is the sum total of all its exhibits. In the Second Exposition there were 187 exhibitors. Through some apparently sinister circumstance three of these failed to fulfill the three particular things Mr. Roush had in mind in visiting the exposition. He seems to conclude from this that the entire exposition was a failure. This is the first occasion where we are informed that the sum is equal to any of its parts. Upon this same basis a college or university can be judged a failure because a graduate from one of its courses fails to come up to the standards of some individual.

This is the first criticism we have heard, and when sufficient consideration is given to the fact that over 80,000 people attended the Second Exposition, and were of the opinion that the exposition was a huge success from every standpoint, it cannot be denied that there is something radically wrong in this individual case.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES,  
By CHARLES F. ROTH, Manager.

### Activities of an Impostor

#### To the Editor of Metallurgical & Chemical Engineering

Sir:—The writer thinks the industry should be advised that there is an impostor going about under various aliases who is a very plausible talker and is very well posted regarding various chemical companies and the men connected therewith.

It appears to be his practice to make an appointment by telephone, at the same time securing information which may be of value to him, such as the names of the company's officers, etc. After a short call, during which he talks familiarly about your business and your customers, he starts to leave and then casually requests the loan of ten or fifteen dollars until the following day, as he has to entertain some friends and is short of funds.

The writer was duly "touched" a short time ago by this man who was then masquerading under the name of West—this is the last seen or heard of this smooth gentleman.

Mr. West (?) is of medium height, with sparse hair

tinged with grey and one of the middle teeth in the lower jaw is missing.

I might say further that one of our employees was "touched" for a loan by the same man, then using the name of "Lloyd" at the Chemical Exposition last fall. Unfortunately the writer learned too late that the party in both cases was the same man.

I hope this notice may prevent some possible future victim from being separated from his hard-earned "simoleons."

J. R. PITMAN.

New York City.

### Silico-Manganese As a Steel Deoxidizer

#### To the Editor of Metallurgical & Chemical Engineering

Sir:—In line with your "An Opportunity for Metallurgists," I want to call to your attention the fact that the Pacific Coast is already preparing to supply the needs of manganese in the shape of a new alloy, silico-manganese. When I use the word "new" I do so guardedly. This alloy has been used quite extensively in Europe, and just to a very limited extent, prior to the war, in the United States.

The State of California holds extensive low-grade manganese deposits, high in silica and low in other impurities, which lend themselves readily to the manufacture of silico-manganese.

Silico-manganese of an analysis containing approximately 60 per cent of manganese and 20 per cent silicon, should be a most acceptable alloy to the steel manufacturers, since it supplies the two alloying metals, manganese and silicon, in proportions much desired by the steel metallurgists.

Silico-manganese, of analysis as outlined, can be obtained for a price considerably less than that of ferro-manganese, at the present time, and eliminates the double freight charges on ferro-manganese and ferro-silicon, as well as the double handling of these two alloys at the open-hearth furnace.

J. W. BECKMAN.

San Francisco, California.

### A Suggestion on Patent Litigation

#### To the Editor of Metallurgical & Chemical Engineering

Sir:—There has been much said about patents, patent litigation, and its effects on industry. This is especially pertinent at present. What is needed now is something practical and applicable to war conditions. I will therefore offer my suggestion.

Suppose there is a real-estate litigation. I believe this has been proved by experience to be best handled before a jury in open court.

Now, a patent is a title to *intellectual real estate*—otherwise called invention.

It therefore seems to me that the way for our country to handle a patent suit might be to follow the rules promulgated for Federal practice by our Supreme Court in the fall of 1913 and to superimpose on this a jury of engineers, technologists and inventors, twelve good men and true and the peers of the litigants. Most of us



to-day know something of patent law, and with the evidence all prepared, with oral examinations so that the jury could tell by manner and voice which expert was trying to dodge and which was sincere, brief and earnest, and with a Judge asking questions and expounding the law, a final and just decision could be easily obtained in a minimum of time.

It seems that in the future, say for the next five or ten years, there will be extraordinary progress in invention, research and applied science, and that some truly efficient way to get results in patent litigation must be attained. If one-tenth the mental, spiritual and volitional energy that is now wasted in our country in fighting with each other and in the honest men fighting the grafters, could be applied in Flanders, K. W. would be dethroned, die Deutsche Republik formed, and aforesaid K. W. would be applying for a job as door-keeper in our Wall Street District.

The above suggestion is given in a tentative manner in order to help settle a most important matter and one affecting the progress of our militant industries and our successes in arms. This war may be a long one. It will be won by inventions. Inventors, while not grasping, expect pay for their work. Above all, the uncertainty and resulting indecision that comes from our present troubles in the courts could be prevented.

In these premises, I might say that *au fond* our patent laws and patent practice are not so bad as usually regarded; in fact, are quite good. It seems to me simply that the ways and means are not well applied. Nor are champertous patent lawyers entirely unknown. What is needed right now is a strict enforcement of present rules and procedure, fewer patent lawyers and more good ones.

My suggestion might well take the form of a court of arbitration established by our national technical societies. The experience of Denmark with a court of arbitration of business men in general civil cases, would lend weight to the proposal. In this Danish court, the findings are so clear, so honest, and so intelligent that the decisions, though quick, are practically never appealed.

All the above is given in outline and in syllogistic form. For its brevity—and it may be considered even witty if brevity be the soul of wit—no apology is needed in a time when words are at a discount and only sell when they conduce to action.

WOOLSEY MCA. JOHNSON.

New York City.

#### Antimony in Zinc Electrolytes

To the Editor of Metallurgical & Chemical Engineering

SIR:—I am enclosing description of materials and a method for determining antimony in zinc electrolyte solutions which may be of assistance to other chemists, as we have used it successfully for three months. I believe it is considerably shorter than most of the methods being used on zinc solutions.

The materials required are:

1. Buechner funnel, large filtering flask, filter pump,  $H_2S$  generator, 2000 cc. beakers, 250 cc. beakers, fine filter papers (similar to Munktell's Swedish No. 0).
2.  $HCl$  and  $H_2SO_4$  free from  $As$  and  $Sb$ ; granular  $KClO_3$ ,  $HNaCO_3$ , or  $HNH_3CO_3$ .
3.  $Na_2S$  solution, about 5%.

4. Pure  $Na_2S$  solution, about 3%. Iron may be removed by allowing the solution to stand two or three days in sunlight, and then filtering.
5. Standard iodine solution containing 2.12 gm. iodine per liter, dissolved with  $KI$ . 1 cc. = 0.0010 gm.  $Sb$ . Standardize against  $Na_2S_2O_3$  solution (5 gm. crystals per liter;  $Cu \times 0.9454 = Sb$ ). If preferred, the iodine may be standardized against an antimony solution prepared as follows: Take 0.120 gm. of pure  $Sb_2O_3$ , and 200 cc. of the  $Na_2S$  solution and heat until dissolved, dilute to 1000 cc. and filter. 10 cc. of this solution contains 0.0010 gm.  $Sb$ . 50 or 60 cc. may be heated, treated with  $KClO_3$  and  $HCl$  and finished exactly like the assay, as detailed below.
6. Starch indicator: Take 500 cc. of a cold saturated solution of  $NaCl$ , filter, add 100 cc. of 80% acetic acid and 3 gm. of starch. Mix cold, heat and boil until nearly clear. Add about 30 cc. water, cool and place in a bottle. This solution will keep indefinitely.

The following is the method of making the determination:

Take 1000, 1500, or 2000 c.c. of the solution to be analyzed, add enough  $H_2SO_4$  to make about 10 per cent acid by weight, heat to 80 deg. or 90 deg. C., and pass in  $H_2S$  for 30 to 40 minutes. Filter by suction on Buechner funnel, using double filter papers. Wash well with warm  $H_2S$  water acidified with  $H_2SO_4$  to remove all zinc.

Remove the filter paper, fold it as usual and place it in an ordinary funnel, with one fold extending diametrically across to expose all of the precipitate. Wash with about 30 c.c. of the hot  $Na_2S$  solution, at first pouring part of filtrate through the paper again. Wash twice with hot water. The  $CuS$  remaining on the filter may be dissolved in small volume of hot 1:1  $HNO_3$  and copper determined by the iodide method. For solutions containing much copper, the paper containing the  $Sb_2S_3$  and  $CuS$  is best boiled with  $Na_2S$  solution and filtered on a separate paper (S & S No. 597).

Heat the filtrate nearly to boiling, add about 0.2 gm.  $KClO_3$ , stir to dissolve, add 15 c.c. of strong  $HCl$  and boil for a few minutes. Allow the solution to cool one minute, add 5 c.c. of the  $Na_2SO_3$  solution, and boil for 5 minutes. Allow it to cool one minute, and treat again with 2 or 3 c.c.  $Na_2SO_3$ , and boil. Repeat this operation once more and then boil 30 minutes to remove  $SO_2$ . (Repetition of this reduction is almost always necessary, especially if more than 0.005 gm.  $Sb$  is present.)

If more than a trace of arsenic is present, the solution should be evaporated to 10 c.c. to remove it.

Cool the solution, make it slightly alkaline with ammonia, then slightly acid with the starch indicator containing acetic acid. Cool again, make up the volume to about 100 c.c., add an excess of  $HNaCO_3$  or  $HNH_3CO_3$ , and titrate immediately with iodine to a permanent blue color.

With care and the use of pure reagents, the limit of error should be less than 0.0003 gm. of  $Sb$ . Complete assay requires less than 3 hours.

For high  $Sb$ , it might be well to add a little tartaric acid after the first treatment with  $Na_2SO_3$ , but we have never found it necessary.

In working out this method, much assistance was obtained from Scott's Standard Methods of Chemical Analysis (D. Van Nostrand Co.), Prescott and Johnson's Qualitative Chemical Analysis, and Low's Technical Methods of Ore Analysis.

H. F. BRADLEY.

Park City, Utah



### Coming Meetings and Events

Third National Exposition of Chemical Industries, Grand Central Palace, New York, Sept. 24-29, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 25 to 28, 1917.

Technical Association of the Pulp and Paper Industry.—Joint meeting with the Technical Section of the Canadian Pulp and Paper Association, Holyoke, Mass., Sept. 27 to 29, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Gas Institute, Washington, D. C., Oct. 16-19, 1917.

American Society of Mechanical Engineers, New York, Dec. 26-29, 1917.

### Western Metallurgical Field

#### Smelter Investigation in Colorado

One of the "set pieces" at Colorado's legislative sessions for some years past has been a bill providing for the investigation of smelting concerns doing business in the State. Generally, it has been conceded that these measures, in the main, have been directed against the American Smelting & Refining Co. by legislators from the mining districts, who introduced them largely for political effect and for home consumption. In any event, none of them ever became law, and all met the customary finish in committee rooms. All were inspired by the vague notion that the smelter trust was robbing the miner in high treatment charges; and the legislators usually took their cue from a few shippers of small consequence, who, however just their cause, were not sufficiently conversant with the business to analyze it and get to the root of the matter. This is not to say that there were not reasons for dissatisfaction, for there were; but the proposed remedies were poorly conceived, by men who failed to recognize, first of all, that smelting is a highly technical business, which cannot be legislated upon without some knowledge thereof. Further, the industry is in the hands of comparatively few men, so that knowledge of its inner workings is not widely spread.

It was almost a foregone conclusion that the Colorado legislative assembly this year would pay its usual respects to the smelting industry in the form of a bill for an investigation of the buying and selling of ores. Two bills were introduced, one of which was better than the other in that it recognized the technical nature of a sound investigation, and proposed a committee of experts to conduct the same. The bill finally adopted was a combination of the features of each. It provides for the appointment of an investigating committee of five, comprising two Senators appointed by the President of the Senate, and three Representatives appointed by the Speaker of the House. This committee is charged with fully investigating "the buying, selling, exchange, refining, treatment, smelting and reduction of metalliferous ores or ore concentrates, the charges, rates, schedules and returns therefor; and shall cause to be filed with the Public Utilities Commission of this State, on

or before the first day of January, 1918, its complete report and findings in writing, containing such recommendations as it shall deem appropriate in the premises."

The committee was authorized and empowered to conduct hearings, subpoena witnesses, and compel the production of records and documents. The bill carried an appropriation of the sum of \$15,000 to carry out its purposes.

Obviously, the weak feature of the act is a politically appointed committee, because the public has no confidence in such a committee appointed to investigate a technical matter. Herein the bill was poorer than the one for which it was substituted. The committee appointed comprises Senators Siewers Fincher and William J. Candlish, and Representatives A. P. Ardourel, D. J. McDonald and H. P. Nagel. Realizing, perhaps, the lack of technical knowledge in the committee as a whole, it secured the services of Mr. O. R. Whitaker, consulting engineer of Denver, to review its findings and aid in preparation of the report. The selection of Mr. Whitaker will place the stamp of integrity on the conclusions drawn from the data furnished him by the committee, and it is to be hoped that the information is complete.

It is not unlikely that the report will criticize the smelters in some respects and exonerate them in others. Whatever the result, it is almost certain that the entire affair could have been avoided by a more liberal policy of publicity on the part of the smelters in years past. It has seemed as though the American Smelting & Refining Co. has been particularly dense in failing to get the spirit of the times, and slow to see the wisdom of explaining many features of its business to those on whom it was dependent for patronage. Admitting that many features of the smelting business are not understood, even by those deeply concerned, there exists the greater reason for that friendly spirit of confidence and co-operation that so many corporations have found profitable. A campaign of education on the part of the smelters for the purpose of enlightening miners on some of the more abstruse features of contracts, and a policy of simplifying and clarifying the method of computing ore values, would tend to make friends. This would be a big accomplishment, because in the last analysis the smelters' great lack is friends in sufficient preponderance to nullify any agitation for an investigation. Taking the mining public into their confidence would be good business, and perhaps one effect of the present investigation will be to educate the smelters to such a policy.

#### Canadian Mineral Production

The Department of Mines of Canada has issued its preliminary report of the mineral production of the Dominion for the calendar year 1916, showing a total production of \$177,357,454. This is an increase of \$40,248,283, or 29.3 per cent, over that of 1915. The previous maximum production was \$145,634,812, in 1913. The report cites the progress made during the year in establishing and increasing smelting and refining capacities, notably the electrolytic zinc and copper refineries at Trail, the construction of a nickel refinery at Port Colborne, Ont., the production of metallic magnesium at Shawinigan Falls, ferro-molybdenum at Orillia and Belleville, metallic arsenic at Thorold, and of

stellite, the hard cobalt alloy for high-speed tool steel.

Nickel was an important product of Canada during 1916, being derived from the ores of the Sudbury district, supplemented by the recovery of smaller amounts from the silver-cobalt-nickel ores of the Cobalt district, and a small tonnage of nickel ore from the Alexo mine in Temiskaming. The Sudbury and Alexo ores are reduced in smelters and converters at Copper Cliff and Coniston to a matte containing from 77 per cent to 82 per cent combined nickel and copper. This matte is shipped to Great Britain and to the United States for refining. Nickel was recovered as a by-product in smelters at Deloro, Thorold and Welland, from the ores of the Cobalt district, these sources yielding 323,418 lb. of nickel oxide, 232,450 lb. of nickel sulphate, and 79,360 lb. metallic nickel. Cobalt also was produced at the same smelters. Among important non-metallic minerals produced in the Dominion we note asbestos, feldspar, fluorspar, gypsum and salt.

The interesting annual report of Arthur A. Cole, mining engineer for the Temiskaming and Northern Ontario Railway Commission, gives data on the mining industry in the Cobalt and Porcupine districts of northern Ontario. Gold production showed a steady increase over previous years, coming from the Porcupine, Kirkland Lake and Munroe districts. Silver production from the Cobalt district fell off nearly 3,000,000 oz., but showed an increase in value of over \$1,000,000 due to the rise in the price of the metal.

A feature of the report relates to the use of flotation in Cobalt, showing the following plants and tonnages:

Mill	Tons daily
Beaver .....	30
Buffalo .....	600
Coniagas .....	200
Dominion Reduction.....	200
McKinley-Darragh .....	200
National (King Edward).....	100
Nipissing .....	300
Northern Customs.....	200
Total capacity.....	1830

The use of the flotation process is making available for treatment current slime production as well as old tailing dumps, aggregating a quantity of about 2,500,000 tons. Assuming a recovery from the latter of 4 oz. silver per ton, a possible profit of \$3,375,000 is shown.

#### Copper Output at Low Ebb

With the exception of several of the independent mining concerns, ore shipments from the Butte district are practically at a standstill in consequence of labor troubles. Production at the Anaconda mine in August was only 11,175,000 lb. of copper, as compared with 12,400,000 lb. in July and 28,800,000 lb. in August of last year. Labor troubles were responsible. Production for September will be very low indeed.

The Miami Copper Company reports an output of 160,000 lb. of copper in August, as compared with 4,498,595 lb. for the corresponding month last year. During July the mine was closed on account of labor troubles. Affairs at the Inspiration Copper Company's mine are much improved. Mining operations were resumed Aug. 24 and it is hoped that the output will be back at normal by the end of this month.

#### Minerals Separation vs. Butte & Superior

On August 25th Judge Bourquin, in the U. S. District Court, Butte, Mont., handed down his decision and opinion in the Minerals Separation et al. vs. Butte and Superior Mining Company.

The gist of the opinion is that the defendant having admittedly used the plaintiff's patented process in all of its elements until January 7th (the time of the Supreme Court decision), cannot now avoid infringement by adding, because of that decision, an excess of inert petroleum oils. Of this Judge Bourquin says:

"The addition of the excess oil no more adds to or changes the process, no more avoids infringement, than would the addition of milk or other useless substance not a part of the process."

It is interesting to note that the operation upon which this infringement suit and opinion is based differs materially from the operations considered in the opinion of the U. S. Court of Appeals in the Miami case. Nor is this opinion, we would take it, of quite so wide an interest to the mining public, because of this fact that the Butte and Superior use the mechanical agitation process while in the Miami case a different and much more widely used form of flotation apparatus was involved.

In the Butte and Superior case the plaintiff's patented process in all of its elements was used, except that the quantity of the oil was brought without the claim of the patent, for the admitted purpose of escaping the patent, and, apparently, with poorer results. Whereas, in the Miami case a different procedure was used, but retaining the same amount of oil as the patent, getting a better and more economical result.

As to the Butte and Superior's increase of the oil to an amount without the claim of the patent, Judge Bourquin says:

"The evidence likewise persuades. If the excess were effective and useful and not inert, useless and harmful, it would be without the claims of the patent, would be that of the patentees abandoned to the public, and no infringement."

In the Hyde case, the record of which was before the Supreme Court, and more particularly in the Miami case, in its argument before Judge Bradford, the plaintiff laid the greatest stress upon the reduction of oil; to such an extent indeed was this emphasized that Judge Bradford, in his opinion, stated that the reduction of oil, as compared with the prior art, is so great in itself as to constitute invention, and upon that ground sustained the validity of the patent.

Judge Bourquin says:

"The tendency *was* [italics ours] to attach prime importance to reduction in amount of oil used, when in fact this is but a necessary incident (for which there are substitutes if not equivalents) to the creation of an infinitude of bubbles that do the work."

He then says that the patent clearly states the way to create this infinity of bubbles, and that they do the work. He says that the patent clearly points the skilled operator "the infinitude of bubbles and the degree of agitation and the amount of soap or oil to produce such bubbles."

In regard to the "critical proportions" of oil, as annunciated by the Supreme Court in its Hyde case decision, Judge Bourquin says:

"There are 'critical proportions' of any oil used in this process, perhaps not a sharp divide, but rather a



broad one, for the amount of oil to produce sufficient and efficient bubbles must depend upon many other factors, viz.: the working cell space, amount of water, degree of agitation, kind and amount of ore, and perhaps on occasion, amount of metallic content, kind of oil, etc."

He also says:

"The patent describes oil 'considerably reduced' and refers to a 'fraction of one per cent' by way of example, and some claims limit oil to such a fraction, and a limited range within it, others are for a 'small quantity,' and for that reason held invalid by the Supreme Court. With later knowledge of this suit it is doubted that such would be the decision now. It is to be observed that limitation of the patent indicates that the Supreme Court believed the process might be operated with one per cent and more of oil, and contemplated that this would not defeat the patent, but might affect infringement."

As to the air Judge Bourquin says:

"At the same time, though heretofore somewhat ambiguous and obscure, present knowledge warrants the conclusion that the gist of this remarkable and valuable process and the actual discovery and invention are that whereas theretofore in ore concentration air had been used in desultory and fugitive bubbles as a makeshift incident of and supplement to oil and skin flotation, air can be made to do all the work by creating in water, or pulp, modified by a suitable oil contaminant an infinitude of bubbles."

"It is the first of its kind and the patent sufficiently discloses it and methods to those skilled in the art."

And further on he adds:

"How the air particles are introduced into the pulp is immaterial. For introduced they are still particles and not bubbles. It is this subsequent agitation within the claims of the patent which agitates 'the mixture until the oil coated mineral matter forms into a froth' or 'to form a froth.' And it is all one whether this be applied agitation or self-agitation, the agitation set up by the air particles themselves in merely rising through the mass and thereby coming in contact with both water and oil, all co-acting to form bubbles which capture the metal."

The foregoing paragraph is of interest because of its reference to the agitation in the process. The closing sentence of the paragraph especially so, in that it would appear to be opposed to the recent decision of the Court of Appeals in Philadelphia as to the degree of agitation necessary to bring it within the claims of the patent. The question of relative agitation, however, is not an element of the Butte and Superior case, since the agitation which was used is admittedly that of the patent.

As to the new evidence, over that of the Hyde case, Judge Bourquin says:

"The great mass of new evidence herein is but cumulative of the Hyde suit. The only new publication is the California Journal of Technology detailing a suggestive but rather misleading and abandoned experiment sufficiently referred to in the Miami suit."

The defendants had placed much dependence upon this publication in the California Journal of Technology because of its absolute description, as they consider it, of the "agitation froth," its method of production and characteristics, as antedating by some years the time of the invention of the patent.

As to the weight of new evidence necessary under the circumstances, the Supreme Court having declared the patent valid, Judge Bourquin says:

"If it be conceded that new evidence might warrant and demand that a trial court hold invalid a patent by the Supreme Court held valid, such evidence must be unequivocal, clear and convincing, in quality and quantity that inspires confidence and produces conviction, that the patent is invalid beyond reasonable doubt."

Not only does it fail here, but it strengthens the conviction that the patent is valid."

The decision contains some interesting figures as to metallurgical results obtained by the Butte and Superior when using the process, and treating some 1,598,000 tons of ore.

YEARLY AVERAGES				
Year	Material Treated, Per Cent	Oil Used, Pounds	Concentrate Grade, Per Cent	Apparent Recoveries, Per Cent
1913.....	15.14	5.58	47.60	80.03
1914.....	14.14	2.22	53.03	86.08
1915.....	13.66	1.49	54.62	90.18
1916.....	12.89	1.43	53.83	92.63

"Progress is noted by leaner ores, less oil, higher grade concentrates, and greater recoveries, all coincident with advancing time."

says Judge Bourquin. It is not clear just what the Judge intended to convey by that comment. Such improvement was undoubtedly due more to the metallurgical attention of the operators of the process than to any particular information contained in the patent itself. The sudden necessity in which they found themselves of disarranging all that they had been doing would also, naturally, account largely for the "poorer results" of the increased oil. But we are not sufficiently familiar with the evidence before the Court even to suggest this.

The Judge's comment as to the fact that had the larger amount of oil been more profitable they would undoubtedly have found it out prior to January 7 is certainly impressive, and it is natural that one would, upon the face of it, be unfavorably impressed by any simple evasion such as the opinion sets forth.

We must now await the decision of the Court of Appeals, which may, as they did before in the Hyde case, find more in the prior art, and greater weight in the new matter, than has Judge Bourquin in his opinion.

## Fall Meeting of the Paper Industry

American and Canadian Technical Associations to Meet at Holyoke, Mass.

All arrangements have been completed by the local committee at Holyoke, Mass., for the joint convention there on Thursday, Friday and Saturday, Sept. 27-29, of the Technical Section of the Canadian Pulp and Paper Association and the Technical Association of the Pulp and Paper Industry.

The business meetings will take place in Knights of Columbus Hall, Holyoke, the opening sitting being scheduled to start promptly at 10 o'clock on Thursday morning, Sept. 27. The convention will be opened by President Henry P. Carruth with the introduction of Hon. John J. White, Mayor of Holyoke, who will deliver an address of welcome. The response for the association will be made by Martin L. Griffin, of the Oxford Paper Company. The selection of Mr. Griffin is especially appropriate, as he was one of the first chemists to be connected with a paper mill in the Holyoke district.

Among the papers to be presented at the afternoon session are the following:

1. "An Investigation of Stresses in Digester Shells," by Prof. H. O. Keay of the Laurentide Company, Grand Mère, P. Q., Canada.
2. "Clay Retention: Influence of Clay Concentration,



Alum Concentration and of Alum and Size," by Prof. John D. Rue of the Fletcher Paper Company, Alpena, Mich.

3. "Some Observations on the Retention of China Clay by Paper Pulp," by Dr. Otto Kress and George C. McNaughton, of the Forest Products Laboratory, Madison, Wis.

4. "A Review of Different Processes for Causticizing Sodium Carbonate Liquors and the Separation of the Sludge," by Martin L. Griffin of the Oxford Paper Company, Rumford, Me.

The banquet will be held on Thursday evening at the Hotel Nanatuck.

Friday, Sept. 28, will be Visitation Day, an interesting program of visits to paper mills, papeterie plants and allied industries having been provided for members and guests.

The managers of the National Exposition of Chemical Industries have set apart Wednesday, Sept. 26, as "Paper Day" at the exposition in the Grand Central Palace, Lexington Avenue and Forty-fifth Street, New York City, and members of the Technical Association of the Pulp and Paper Industry and the Canadian Technical Section are invited to call and inspect the exhibits of apparatus, machinery and chemical products used in the manufacture of pulp and paper. A representative of the Technical Association will be in attendance at the association's booth to receive visitors and give any needed information.

### Program of the Chemical Exposition

The following is the program of the third National Exposition of Chemical Industries, to be held during the week of Sept. 24, 1917, at the Grand Central Palace, New York. In addition to the addresses listed below, a very large number of attractive motion pictures will be presented, the program of these being shown on page 327 of this issue.

#### MONDAY, SEPT. 24

Afternoon—Opening addresses.

2:00 p. m.:

DR. C. H. HERTY, Chairman, Exposition Advisory Committee.

DR. JULIUS STIEGLITZ, President, American Chemical Society.

DR. C. G. FINK, President, American Electrochemical Society.

DR. G. W. THOMPSON, President, American Institute Chemical Engineers.

#### TUESDAY, SEPT. 25

Afternoon—Lecture.

4:00 p. m.:

DR. ALEXANDER SILVERMAN (University of Pittsburgh),

"Glass Manufacture." Illustrated specimens and stereopticon.

Evening—Addresses.

8:00 p. m.:

DR. M. T. BOGERT, Chairman, Chemical Committee National Research Council,

"The Operation and Work of the National Research Council for the National Weal."

DR. F. W. TAUSSIG, Chairman, U. S. Tariff Commission.

"The Tariff Commission and Its Operation."

DR. GRINNELL JONES, Chemist to U. S. Tariff Commission.

"The Tariff Commission and Its Operation with Reference to the Chemical Schedule."

#### WEDNESDAY, SEPT. 26

Afternoon—Meeting of the Technical Association Pulp and Paper Industry.

4:00 p. m.: Lecture:

M. A. WILLIAMSON (the Norton Co.).

"The Manufacture and Use of Alundum and Crystolon."

Evening—Addresses:

8: p. m.:

MR. W. S. KIES, Vice-president, National City Bank.

"The Development of Export Trade with South America."

MR. C. H. BOYNTON, President, American-Russian Chamber of Commerce.

"Russia and Its Relation to the United States."

DR. L. H. BAEKELAND, Member Naval Consulting Board.

"The Future of the American Chemical Industry."

#### THURSDAY, SEPT. 27

Afternoon—Symposium on National Resources for Chemical and Allied Industries:

2:00 p. m., speakers:

MR. C. H. CRAWFORD, Assistant to President, Nashville, Chattanooga & St. Louis Ry.

"Ahoppa Awan Tewa."

MR. V. V. KELSEY, Chemist-Industrial Agent, Carolina, Clinchfield & Ohio. Ry.

"Building a Complete Cycle of Chemical Industries on the Clinchfield."

DR. T. P. MAYNARD, Mineralogist-Geologist, Central of Georgia Railway.

"Industrial Interpretation of the Mineral Resources Along the Central of Georgia Ry."

DR. E. A. SCHUBART, Mineralogist-Geologist Norfolk & Western Railway.

"The Development of Chemical Industries Along the Norfolk & Western."

DR. J. H. WATKINS, Geologist, Southern Railway.

"Railroad Industrial Preparedness."

Evening—Meeting: The American Institute of Chemical Engineers.

8:00 p. m.: Joint meeting: The New York Sections, American Electrochemical Society, The American Institute of Mining Engineers.

#### FRIDAY, SEPT. 28

Afternoon:

3:30 p. m.: Meeting—American Ceramic Society.

DR. MALINOVSKY.

"Refractory and Stoneware of Malinite."

Evening—Meeting:

8.00 p. m.: New York Section, American Chemical Society.

## The Engineering Council

### Its Organization, Aims and Sub-Committees

The formation of an Engineering Council is the outgrowth of a real need for proper consideration of questions of general interest to engineers and to the public, and to provide the means for united action upon questions of common concern. Many such questions have come up in the past and will arise in greater number in the future. This war has brought out very impressively the actual need for united action of some kind. At present the Council is concerned only with four societies, because that seemed the most practical way of getting a group of men together to answer the immediate needs, but these societies do not assume to speak for all engineering societies in the country. Criticism that they are exclusive in any way is utterly mistaken. There is the hope that such a Council, by proving itself effective, may lead to much wider co-operation in a strictly representative body for all engineers, and thus pave the way for a very much larger union in the future.

How can the Council be enlarged? By a union of all societies, either as the outgrowth of the present Council or by a congress of engineers leading to united action by all societies. The first method will be the most natural one, because many local societies and national societies also have a large membership in the four societies at present concerned. We have three classes of engineers to reach: first, those who are members of local societies and not members of national societies; second, those who are members of national societies and not members of local societies; and third, those who are members of no society. The last named class constitutes a very large number in our profession. We are almost as mixed as American citizenship, and we suffer therefrom just as much as America with a population representing every race and every people in Europe. There can be no question of the enormous advantage of union. That union should be completed by strengthening the existing agencies and not by the formation of new societies. The national societies are thoroughly national notwithstanding an occasional complaint that they are run by New York. If they have not been able to express the democratic spirit of our country as fully as might be desired it is the fault of the members in all the states and not of the city in which the principal offices are located.

The four societies concerned at present are the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. They have come together in pairs from time to time in the past for special purposes, and there have been general conferences on subjects requiring immediate settlement, but until the Council was definitely organized in June there was no permanent body to advise all the societies. We have had many fruitful discussions in the past leading to useful action. The Standardization Committee which has been organized to represent five societies has passed upon commercial standards of all kinds. This committee has great possibilities and it should be enlarged enough so that its influence may become very widespread.

Many problems have already been presented before

the Council. Its personnel made up of twenty-four men representing equally the four societies is well balanced and judicial. The first duty was necessarily the organization and appointment of standing committees, which have already been reported in the press. They might with advantage be mentioned here:

1. Committee on Public Affairs, comprising Messrs. C. W. Baker, G. F. Swain, S. J. Jennings and E. W. Rice.

2. Committee on Rules, comprising Messrs. J. P. Channing, Clemens Herschel, N. A. Carle and D. S. Jacobus.

3. Committee on Finance, comprising Messrs. B. B. Thayer, I. E. Moulthrop, Calvert Townley and Alex. C. Humphreys.

Certain questions relate, however, to the war and the assistance that engineers can render. A committee to be called the American Engineering Service Committee was appointed with instructions to invite the co-operation of all engineering societies. This committee in the first instance consists of A. D. Flinn of the Civil Engineers, A. S. McAllister of the Electrical Engineers, George J. Foran of the Mechanical Engineers, G. C. Stone of the Mining Engineers and E. B. Sturgis of the Mining and Metallurgical Engineers. Its present duty is the tabulation and listing of the members of the five societies represented, in order that we as a profession may be in a position to take a larger part in the industries after peace is declared. This tabulation has already in part been done, but in a rather unsystematic and unequal way. It is hoped that the new committee by having additions from other societies may make a final and lasting tabulation of all the engineers in the United States. The list is to be kept in the Engineering Building for general use in Government problems and in the industries. At present the committee is devoting its attention to the immediate need of the hour, namely, the procurement of men for special service in the Government. A list of specialists in the societies has already been completed. There are three methods by which engineers may enter United States service: first, through some organization; second, through individual application to a department of the Government; and third, through selection by the Conscription Law. But this is war service wholly and not civil service, which is the same now as it has always been. As a matter of fact, a great many engineers have already entered through the engineering societies, through colleges and through various special boards in Washington. The importance, however, of a complete list of engineers and their professional specialties cannot be over-rated. Such a complete list can be made only with the help of the local as well as of the national societies. The committee mentioned above is organized with George J. Foran as chairman and A. S. McAllister as secretary. All societies should respond to the request for co-operation.

Another committee, of which Harold W. Buck is chairman, is called the War Committee of Technical Societies. The members are Messrs. H. W. Buck, A. M. Greene, R. N. Inglis, C. R. Corning, G. C. Stone, D. W. Brunton, J. M. Boyle, J. V. Davies, Joseph Bijur, A. S. McAllister, W. D. Richardson and Charles Baskerville. It was appointed to assist any organization in Washington, such as, for instance, the Council of National Defense, the National Research Council and the Naval



Consulting Board, in any way in which it can bring to the attention of the engineers of the country the necessity for thought and help in the numerous problems that arise.

A council organized by the enlargement of the present Engineering Council can be very effective in many ways without interfering with the autonomy of any individual society. Every society has some definite purpose of its own, and also some which it holds in common with all other societies. One of the latter purposes relates to public service and to co-operation. To the end that all societies may understand fully their opportunity, the committee of which Mr. Foran is chairman has made a complete list of all the societies and their officers, and communications will be sent out inviting co-operation, and it is hoped that the Council may be successful in arousing sufficient interest to bring about a larger and better Council for all engineers.

In organizing the Council provision was made for the election to membership of other national engineering and technical societies. There is no doubt that rules can be made under which these societies may become members. This will involve consultation and discussion in the future.

The office of the Council will be in the Engineering Building, 29 West Thirty-ninth Street, New York City.

(Signed) IRA N. HOLLIS, Chairman,

Worcester Polytechnic Institute, Worcester, Mass.

CALVERT TOWNLEY, Secretary,

115 Broadway, New York City.

#### MEMBERS OF THE ENGINEERING COUNCIL

*United Engineering Society*—Clemens Herschel, B. B. Thayer, I. E. Moulthrop, Calvert Townley, secretary.

*American Society of Civil Engineers*—John F. Stevens, George F. Swain, vice-chairman, Fred H. Newell, Alex. C. Humphreys, John D. Galloway.

*American Institute of Mining Engineers*—P. N. Moore, S. J. Jennings, B. B. Lawrence, J. Park Channing, Edwin Ludlow.

*American Society of Mechanical Engineers*—Dr. Ira N. Hollis, chairman, John H. Barr, Charles Whiting Baker, Arthur M. Greene, Jr., Dr. D. S. Jacobus.

*American Institute of Electrical Engineers*—H. W. Buck, vice-chairman, E. W. Rice, N. A. Carle, P. Junkersfeld, C. E. Skinner.

**Record Production of Fluorspar in 1916.**—American mines broke another record last year in the production of fluorspar, as shown by statistics compiled under the direction of Ernest F. Burchard, of the United States Geological Survey, Department of the Interior. In 1916 the shipments were 155,735 short tons, valued at \$922,654, an increase of 14 per cent in quantity and of 21 per cent in value over the shipments of 1915, heretofore the record year.

The increased demand for fluorspar has come largely from the manufacturers of open-hearth steel, who use the mineral as a flux, but the demand for it in other metallurgic operations and for the manufacture of hydrofluoric acid has been very active. One of the newer uses for fluorspar is as a reagent in the recovery of potash from feldspar and from Portland cement clinker.

## Russian Engineers in the United States

Having in view the coming development of the natural resources of Russia in the very near future, the Russian Provisional Government has sent a special delegation to the United States, entrusting it with the task of investigating the conditions existing in the mining and metallurgical industries of this country, as well as the laws relating to the discovery, ownership and development of mineral resources. The commission is headed by Mr. Fedor M. Foss, member of the Bakhmeteff Mission as the representative of the Ministry of Commerce and Industry. Mr. Foss is a mining engineer and director of several mining and metallurgical works in the Ural Mountains, notably Count P. P. Schouvaloff's Lyssvensky properties, producing charcoal iron, tin plates and platinum, and the Upper Issetssky works, producing iron and copper. Mr. Foss has as associates on the commission the eminent geologist Ivan M. Goubkin, who is a specialist in petroleum, and another member of the geological committee, A. A. Snietkoff, a specialist in questions pertaining to coal. Alexander Stepanoff is secretary.

The commission has entered the United States as the leading nation in their development of national resources. They feel that the most modern and economical developments of mining and metallurgy can be found here. Also in such matters as geological surveying, investigation and land classification the United States stands pre-eminent. The Provisional Russian Government therefore felt that it would be most suitable to study all these questions in the United States.

The commission has already been in Washington, where the Geological Survey and Bureau of Mines have opened their records for examination, and have aided the members in every possible way, planning an itinerary covering the entire country, so that Messrs. Foss, Goubkin and Snietkoff can see the work on the spot.

The commission intends to stay not less than four or five months, during a large part of which time the individual members will visit various localities of most interest to them. In the near future they plan upon inspecting the steel works of the Pittsburgh district, the anthracite fields of Pennsylvania and the Michigan copper country. Following the St. Louis meeting of the Institute of Mining Engineers, they intend visiting the oil wells in Oklahoma and the mining and metallurgical centers of the Mississippi Valley and the Rocky Mountains.

Upon returning to Russia, Mr. Foss will present a report to his government, reciting his findings as to the applicability of American methods to Russian problems. While it is yet early in his investigations, Mr. Foss feels at present that it would be of very great advantage to his country if American capital, engineers and plants could be bodily transplanted to Russia by the granting of the necessary concessions. These plants, operating on the most modern ideas, would then be accessible places in which to school Russian engineers, who in turn would spread over their entire country, building new works and developing new processes from this foundation.

The mining, metallurgical and chemical engineers of the United States gladly welcome these brother engineers, and will be more than happy if our work and ideas may be of help to them.



### Sixth Annual Safety Congress

The sixth annual safety congress of the National Safety Council was held at the Hotel Astor, New York City, on September 10th to 14th, inclusive. One of the special features of the congress was an exhibition of devices and appliances pertaining to accident and fire prevention, and sanitation, held during the same week at the Grand Central Palace. This was the largest and most complete safety exposition ever held, and was the center of interest of a large attendance of engineers and managers interested in safety work.

Several general sessions of the entire membership were held thru the week, when topics of general interest were discussed by leading personages, such as **Hon. William B. Wilson**, Secretary of Labor; **Dr. Charles P. Steinmetz**, **Miss Ida M. Tarbell**, and **Dr. Adrian V. S. Lambert**, of the Rockefeller Institute. An imposing list of papers on various phases of human conservation was presented in various sectional meetings, subdividing the membership into the following distinct groups:—Public Safety Division, Public Administrative or Governmental Division, Health Service and Industrial Relations Division, Transportation and Public Service Division, and the Industrial Division. The Transportation Division was subdivided into four sub-sections, viz.: Electric and Street Railways, Marine and Navigation, Public Utilities, and Steam Railroads. The Industrial Division is formed by the following sub-sections:—Chemical and Rubber; Logging, Lumbering and Woodworking; Metals and Metallurgy, including Foundries, Iron and Steel Works; Mining and Quarrying; Automobile Manufacturing; Car Builders; Paper and Pulp; and the Textile Trades. The scope of the activities of the National Safety Council, and the wide influence of this convention can be appreciated after a mere statement of these separate meetings held during this busy week.

The Chemical Section met on Wednesday, Sept. 12th, under the chairman, **Mr. J. R. de la Torre Bueno**, of the General Chemical Company. **Dr. John S. Bates**, of the Imperial Munitions Board of Canada, gave a most interesting talk on "Manhood Conservation in Munitions and Chemical Plants in Canada." **Mr. R. G. Griswold**, of the E. I. Du Pont De Nemours Co., then addressed the section on "General Dangers from Strong and Mixed Acids, from the Safety Man's Point of View." **Mr. Griswold** pointed out that the average workman has no appreciation of the serious results that may arise from contact with strong acids. Pipe fitters, for instance, become exceedingly careless and neglect the essential precaution of first making sure the line under repair is thoroughly drained. Even then it should be insisted that he cover his skin with vaseline, and use goggles, rubber mask and gauntlets, in order to make sure of protection against drip and spirits. Showers, sprinklers or water buckets should be at every hand to deluge any man burned with acid. Nitric acid and fuming sulphuric acid fumes have a caustic effect upon the mucous lining of the respiratory organs, and men in contact with them should be required to wear a first class respirator fitted with an appropriate absorbent filter.

**Mr. E. Fiesinger**, of the Semet-Solvay Co., discussing "The Hazards of Caustic Soda Manufacture and Use," said that the solid caustic soda and liquor of more than moderate strength, especially if hot, attack

the clothing and quickly burn the flesh. Goggles, rubber puttees, rubber or canvas-covered leather shoes on wooden clogs should be insisted upon. The best antidote for a caustic burn is a 2% acetic acid solution, which should be kept in cabinets on each building column, together with a supply of carron oil, which should follow the acetic acid in severe burns. Carron oil is a mixture in equal volumes of filtered lime water and raw linseed oil. *No absorbent cotton* should be used in cleansing these burns.

**Dr. R. W. Chaffee**, Staff Physician of the Solvay Company, read a short paper on the "Prevention and Treatment of Cases of Poisoning by Tri-Nitro Toluol and Picric Acid." **Dr. Chaffee** recommended a strict physical examination of all applicants for work in such plants, and a course of instruction in the nature and danger of his work. A complete change of clothing on coming to work and absolute cleanliness is prerequisite to the maintenance of health. Rubber boots, coats and gloves should be furnished. Thorough plant ventilation is essential. At the first symptom of TNT poisoning the employee should be put into light outdoor work on garden or farm under careful supervision and medical treatment, which must continue some time after recovery to prevent a relapse. Fumes should be combatted by ventilation, good retort construction and respirators. Several thicknesses of fresh cheese cloth saturated with sodium bicarbonate is an excellent respirator. The "itch" which follows contact with picric acid is speedily removed by a few days' change of work.

A paper on "Packing and Plant Handling of Hazardous Chemicals, with Special Reference to Returned Empties," was read by **N. A. Laury**, of the General Chemical Co. **Mr. Laury** thought that the best general package for acid is the standard wood-packed glass carboy, if made of approved materials. Mechanical handling is much to be preferred; two sticks under the side cleats handled by two men is cheaper and much safer than direct handling. Roller skids should be used in most cases. The safest practicable stopper is a ground glass or stoneware plate held on a tar paper, asbestos or rubber gasket, by a wire clip like a fruit jar. The greatest danger to carboys is the weakening of the wooden case by acid, but this can be eliminated by a wood preservative called "Preservol." The author concluded with remarks on the safe handling of hydrofluoric acid.

The metallurgical sections of the council held no less than four meetings, at which some very interesting papers were read, which we hope to publish in full in a later issue. At the Thursday session (Sept. 13) **Mr. Frank E. Norris**, of the American Rolling Mill Co., discussed "Safe Practices in Sheet Mills." **Mr. Norris** pointed out that the sheet mill of fifty years ago was quite similar to the modern mill. The risks are chiefly in handling the raw material and the slippery, sharp-edged sheets. The transportation of packs of sheared sheets entails a big risk, no practical device for this service has yet been made absolutely safe. A large percentage of cuts come in handling sheets to the leveler rolls, which may largely be avoided by sheepskin gauntlets, wool outside. A light mask for workers around spelter pots has saved many splash burns. Twenty-six per cent. of all accidents happen to new men.

## Boston Meeting of American Chemical Society

Important Discussions on Chemists and Chemistry in Warfare

The meeting of the American Chemical Society, held in Cambridge and Boston, Sept. 10-13, inclusive, was characterized by a great seriousness of purpose and a splendid spirit of service to the country. What the chemists are doing and will do will perhaps not be publicly recognized for a long time, but when the story is written, the immense value of the chemists' work will perhaps be better realized. A great many things that the chemists are doing were brought out at the meeting, which was the second that the society has held since the war started. The meetings, which were very well attended, were held in the new buildings of the Massachusetts Institute of Technology in Cambridge.

### Tuesday Sessions

In welcoming the society to Cambridge on behalf of the Northeastern Section, **Dr. H. P. Talbot**, head of the Department of Chemistry of the Massachusetts Institute of Technology, urged everyone to give serious attention to the problems of the war. He said there was no body of men similarly situated which was capable of contributing so much as the chemists. The doctrine of economy must be preached and practised and a large supply of well trained men must be furnished to help win the war.

In his response, **Dr. Julius Stieglitz**, president of the society, said the meeting was called primarily to discuss war problems. He said the officers of the society had done considerable work in connection with the resolutions adopted at the Kansas City meeting to exempt chemists from the draft and keep them in chemical work. The burden of this work was done by Drs. Parsons, Nichols and Bogert. Dr. Stieglitz said he could foresee the time when there would be a decided shortage of chemists.

The only matter of business taken up was the election of Professor **Victor Grignard**, of the Faculty of Sciences of the University of Nancy, to honorary membership in the society. Professor Grignard is in this country as a member of a French commission and was present at the meeting. He expressed his appreciation of the honor in a short speech.

### AMERICAN MADE OPTICAL GLASS

**Arthur L. Day**, director of the Geophysical Laboratory in Washington, gave a splendid address in which he outlined the difficulties encountered in the initiation of optical glass manufacture in America. This country had depended on Germany and France for its optical glass, the prisms, heavy lenses, etc., never having been made in this country. Last April, when we entered the war, our stocks were about used up, and none was available from France or England, as all their surplus was badly needed by their governments.

The details of the manufacture could not be obtained from England or France, as the processes were secret and not known to those governments. The

Bureau of Standards and the Bausch & Lomb Co. had made a few experiments leading to the synthesis of these glasses, which was the extent of American efforts up to April. At that time a conference was held in Washington and the Geophysical Laboratory was asked to devote its time to this work.

The problem was to make out of American raw materials a tolerable glass and make it quick. On investigation it was found that there was but scanty published information on the relation between the ingredients and the refractive index of the glass. Only about one-third of the last thirty years of its development is recorded in the literature.

After careful figuring by the army and navy officials it was decided that six was the minimum number of different kinds of necessary glasses. The problem was accordingly taken up with the manufacturers, who had suitable furnaces, and a tolerable glass has been produced, but much further improvement is however needed.

**Mr. Day** expressed most cordial appreciation of the assistance given in the work by the Bausch & Lomb Company. The difficulties in producing the glass were first: that not enough was known of the relation between the ingredients and the optical products, as has been mentioned before. A great deal of information has now been collected on this angle of the situation. Secondly, the possible American raw materials are not well known, nor thoroughly available, and not entirely pure. For instance, iron affects the transparency of the glass and the ingredients must be iron free.

The glass making pots must not be corroded too much since American clays contain 2.5 per cent iron, as compared with 1.5 per cent. in the French clays. The importance of this is obvious when it is realized that not more than 0.02 per cent. iron should be present in the resulting glass.

A further difficulty was in securing pure potash. This requirement has been practically met by the Armour Fertilizer Works, which has recently produced a pure potash, free of sulphur and chlorine.

**Mr. Day** concluded by saying that in October 45,000 lbs. of optical glass would be turned out in Rochester, and that if the raw material could be obtained in a pure enough condition, a glass equal to any glass used in Europe could be made with the knowledge obtained since April.

### CONFERENCE ON CHEMISTS AND CHEMISTRY IN WARFARE

The conference on Tuesday afternoon was the most interesting feature of the meeting. The society was fortunate in having present **Dr. Wm. H. Nichols**, Chairman of the Committee on Chemicals of the Council of National Defense, and **Dr. M. T. Bogert**, Chairman of the Chemistry Committee of the National Research Council. **Dr. Nichols'** address is abstracted very fully on the following page.



### Work of the Committee on Chemicals

BY WM. H. NICHOLS

It cannot be impressed too frequently or too strongly on the minds of the American people that the war on which we have entered is one which will require the faithful services and intelligent co-operation of every loyal citizen of the Republic, male and female, until the very end. No half-way measures will suffice. We are pitted against a power which has been preparing for many years and which did not strike until its preparations were complete. With that thoroughness for which the German people are deservedly noted, assisted and guided at every step by a highly intelligent Government, which, for many years, knew what it was aiming to accomplish, and intended to be ready for any eventuality, there was probably nothing which could be foreseen by human intelligence which was not provided for when the Belgian frontier was crossed. While this was true in all fields it was particularly true in the field of chemistry, which has proved to be in many ways the most important science made use of in the titanic struggle. Many of those present will remember the striking lecture of Dr. Bernthsen, delivered during the Eighth International Congress of Applied Chemistry to an audience which packed the hall in its eagerness to learn the last, and to many the first words on the fixation of atmospheric nitrogen. Probably no one among them realized the enormous influence which the process described was so soon to have on the fate of the world. We had been accustomed to consider that nitrogen fixation was practically dependent upon the electric arc and involved the consumption of enormous electrical energy. Dr. Bernthsen's exposition of what is known as the "Haber Process" was so clear and so skillful that even those who gave it only a passing thought could see the great potentialities of employing hydrogen instead of oxygen in the fixation process. Since the date of the delivery of that lecture in 1912 the production in Germany of nitric acid and ammonia in its several forms has become colossal and it may be safe to say that without the process alluded to the war from the German side would long ago have languished from scarcity of explosives, and the fields have become barren from lack of nitrogen. It is conceivably not too much to infer that the war was not launched until the way was clear for the production of nitrogen compounds after the vast accumulated stores of Chilean nitrate had become exhausted. This is one instance of many which might be cited to show the extreme preparedness of the German nation. From my own knowledge I can say that, by comparison, the English and French were unprepared, both in men and equipment and this was thoroughly understood by their enemies. As for Russian preparation, it was carefully looked after in Berlin.

While the beginning of the war found England and France not only unprepared but almost stunned by the suddenness of the shock, they lost no time in getting under way. At first many mistakes were made, and many steps taken which had to be retraced, but fortunately no vital errors were committed. As a result of the gigantic program laid down, covering every phase of preparedness, these countries found themselves able to supply the vast armies which they organized with every article, to the last detail, needed to make them effective. This offers one of the most extraordinary ex-

amples of intelligent co-operation which the world has ever seen. It is little short of a miracle.

Promptly after the declaration of war our authorities at Washington proceeded to take steps with commendable rapidity. They have been criticized a great deal because these steps have not been more rapid, but those who are acquainted with the difficulties of the situation realize that this criticism is not merited. We are a peace-loving people and had been at peace many years. Ours is a democratic government and no one man or group of men has had such powers as will be found to be necessary before we can hope to effect an organization able to cope with the demands that will be made upon it. Our organization at present is, in my opinion, temporary. Of course, the President is and must be its head. Next to him is the Council of National Defense composed of six members of the Cabinet. After this Council comes the Advisory Commission of the Council of National Defense and the War Industries Board, whose duties are not yet clearly defined. The Advisory Commission is divided up into several committees, among them one on Raw Materials. The Committee on Chemicals is one of the sub-divisions of this, and its functions are advisory. Why one of the most abstruse of all the sciences having to do with some of the most delicate and highly refined finished products should come under the head of raw materials is hard to see, but such is the case. We chemists are accustomed to be misunderstood.

I was honored with the chairmanship of this committee and have organized it along lines which previous experience led me to believe would be efficient. The work has been divided into the following heads:

Acids, Fertilizers, Alkalies, Electrochemicals, Coal Tar By-Products, including Ammonia, Pyrites, Miscellaneous Chemicals and Phosphate Rock.

I was able to secure the service of men well known to the industry as chairmen of these sub-divisions and they in turn were fortunate in obtaining many of the best men in the industry for their special committee members. In all, the Chemical Committee with its sub-committees includes some thirty-seven men. These chairmen meet twice a month in Washington and in the interval are at work endeavoring to solve the problems of production which are assigned to them. I think you understand all the work of the Committee on Chemicals has to do with the actual materials, not with research. This latter subject is in charge of the National Research Council, the chairman of whose chemical committee is a member ex-officio of the Committee on Chemicals, thus keeping both branches in close and constant touch. The Bureau of Mines is represented by its able director.

The committee is located in inadequate offices in the Interior Building, fortunately adjoining the office of the honored secretary of this society whose services are thus easily and quickly obtained at any time. Our duties are many, some merely routine, such as obtaining information for various departments, procuring satisfactory prices for articles needed, keeping in touch with the railway commission to see that goods move as freely as possible, and many other of a like character which will occur to you. In addition to these there are many duties of a more serious character requiring much active and intelligent work. Generally speaking, the manufacturers have responded admirably and there are



many instances of sacrifices being made for which recognition is not expected and probably will not be received. It would be idle to state that there are no exceptions, but every effort is being made to produce satisfactory results without resort to higher authority. We feel confident that as the war progresses the ability of the committee will be found to be equal to the problems as they arise. If, however, it should be found that they are not we understand perfectly that we will be expected to make room for those who are better qualified. The main point is that our army and navy must be supplied with everything that the chemist can give, while at the same time our industries shall be interfered with as little as necessary. It may happen as time passes that in spite of all precaution the industries may suffer to some extent, but you can depend upon it that this will not be the case if it can be avoided by human foresight. There must come a time when this war shall end and we should be constantly preparing ourselves not only to provide its requirements while it lasts, but to meet conditions as we find them at its termination. Many theories have been advanced as to what will happen when peace once more blesses our staggering world, but I believe we should so plan our affairs that whether expansion or contraction results, we will be able to meet either conditions with a bold front.

One of our most serious difficulties arises from the unwillingness of the military authorities to recognize the wisdom of exempting chemists as a class from the draft. Almost from the beginning of our work we took up this question from various angles, realizing as we do the vital importance of keeping chemists at work in their profession not only at the present time but more particularly for the future. Our civil, mechanical, electrical, and other engineers can be made good use of at the front and not only contribute greatly to the success of our forces, but by the valuable experience obtained in their profession can improve themselves for future service at home. This is not true of chemists, with an exception here and there. Once in the army and at the front, if he be only recently out of college he is lost to chemistry forever. They are not slackers and are just as anxious as any other red-blooded young men to get into the fray, and therefore I have believed it wise not only to have them exempted from the draft, but declined in case they should enlist. Already serious trouble has come to many of our chemical plants and plants employing chemists, as a result of the draft, and unless wise provision be soon made we can foresee a condition which it will cost months to rectify. Why should we not take the advantage of the experience of our English friends who have passed through this same situation and learned that there is a large class of men who can do more valuable work behind the lines than they can in the trenches?

The one great need of any colossal organization is the complete co-ordination of all its parts. No one can claim that the organization in Washington has yet reached this stage or even approximated it. Many things are done several times over and many others needed are not done at all. I presume this condition is unavoidable at this stage of our progress but it must not be allowed to continue indefinitely. We have the utmost confidence that the President and his advisors can be relied upon to produce the required organization co-ordinated and articulated so perfectly that it will

work with giant force and with little friction. This will come after politics have given place to patriotism and this will happen, I believe, when the people of the country thoroughly appreciate the fact that we are at war. In any event, I am sure the country can rely upon the 10,000 chemists of this society to do everything that lies in their power to see that the chemistry branch, possibly the most important of all, is not found lacking in either ability or patriotism.

**Dr. M. T. Bogert** then presented an address on the work of the Chemistry Committee of the National Research Council, reviewing their activities in the mobilization of research chemists and coördination of their investigations, both of this country and of our allies. He also mentioned their efforts in the production of cheap and portable hydrogen plants for the aviation corps, and in the absorption of hydrogen gas in the submarine battery rooms, and related U-boat problems. The most important fields of their work is in the production of poisonous gas, gas masks, gas shells, and so on. We hope to publish this address in full in our succeeding issue.

Following **Dr. Bogert's** address, **Dr. Roger Adams**, of the University of Illinois, told of the work which was being done there in making some of the rarer organic chemicals, badly needed by laboratories for analytical and research work. About ten men are employed and about 80 different products have been made in one- and two-pound lots.

**Dr. Stieglitz** then called on **Dr. Angell**, another member of the French commission, who gave an interesting talk (in English). He said it was a very great mistake to allow the chemists to go into the trenches, as was done in France, where 60 per cent. of the young chemists had been lost. It took a long time to have scientific men recognized as of value by the military authorities. The reason for this was that the officials did not know where they were needed. At the present time, however, France's laboratory and chemical manufacturing system is very well organized for war work, the government controlling practically all the explosives' manufacture. **Dr. Angell** said his commission had come to the United States to acquaint American chemists with what France had done in order to avoid duplication of effort and to co-operate in any way possible.

**Dr. A. A. Noyes**, a member of the committee appointed to investigate the nitrate situation, then told of the recommendations of the committee, which matters are discussed fully on pages 255 and 261 of this issue. He said the conversion of  $\text{NH}_3$  into  $\text{HNO}_3$  worked out by co-operation with the Semet-Solvay, General Chemical and Cyanamid Companies, gave an efficiency of 90 per cent., and was very satisfactory. He said no large scale attempts had yet been made to convert cyanide into ammonia by steam in the Bucher process.

### Wednesday Sessions

On Wednesday and Thursday divisional meetings were held by the fertilizer, rubber, pharmaceutical, industrial, biological, physical, inorganic and organic sections. Of especial interest was the conference held by the Industrial Division, Wednesday morning, on "The Industrial Chemist in War Time."

The sessions were presided over by **H. E. Howe** of **Arthur D. Little, Inc.**, Boston, chairman of the division.

The whole time Wednesday morning was given over to a series of talks on the part of industrial chemistry in the war.

Dr. W. H. WALKER head of the chemical engineering department at M. I. T., said there was a shortage of industrial chemists and that more men must be brought into chemical engineering. He said it was more difficult to start a man in chemistry than in other branches, owing to the difficulty of translating it into every-day experiences. The course is also more expensive and this is often a deciding factor. Institutions should have loan funds to help needy men, and the men should be shown more clearly the opportunities existing in the chemical engineering field.

Dr. HILDEBRAND of the Bureau of Standards, Washington, D. C., described the work which was being done there in the new chemical building, on war problems.

Dr. L. H. BAEKELAND, member of the Naval Consulting Board gave a very interesting talk on the work of the Board. The Naval Consulting Board was created to pass on inventions for the Navy. It now, however, also passes on them for the Army. The overwhelming majority of the suggested ideas are not worth much, and it has been necessary to issue a pamphlet telling the people what not to do. In suggesting new articles to be used, the questions of their economical manufacture and availability of raw materials are not considered. He said *new explosives* is not what is wanted but a good supply of what those we already know about. The experience which England had with cordite is illustrative. This explosive needs acetone which is a scarce article today in England. It would have been better to adopt an explosive needing ether, as its manufacture is easier.

Dr. CHARLES L. PARSONS told of some of the activities of the Bureau of Mines, which has been devoting its attention to such problems as the supply of pyrite and elemental sulphur, the manganese supply, use of low grade ferromanganese, electric furnace for melting of brass, special steels, concentration of molybdenum ores, quicksilver production from low-grade ores, apparatus for oxidation of ammonia to nitric acid, production of mesothorium from monazite, and gas warfare.

Others who spoke at the conference were Dr. Charles H. Herty, who made a plea for greater publicity of chemistry, and Prof. A. H. White of the University of Michigan, who is a captain in the Ordnance Department, who said he had been most pleasantly surprised by the treatment of civilians who entered the war department. Charles F. Quaintance, secretary of the company manufacturing Coors porcelain, made a plea for a continuance of the support of American chemists of our domestic porcelain manufacturers. He said that foreign products should not be allowed to destroy our industry. Dr. Bigelow of the National Canners' Laboratory gave an interesting talk on the food situation. Professor Olney of the Lowell Textile School and Dr. Hawley of the University of Wisconsin also spoke.

#### INDUSTRIAL DIVISION

The regular meetings of the Industrial Division started on Wednesday afternoon. Officers elected for the next year were W. H. Walker, chairman, S. H. Salisbury, Jr., secretary. At the Wednesday afternoon session two papers were presented by GUSTAV EGLOFF, who was, however, personally unable to read them as he was called West unexpectedly. Both the papers were short,

the first describing the cracking of solvent naphtha in the presence of Blau gas.

The second dealt with the "effect of pressure on the formation of benzene and toluene from gas oil."

Gas oil derived from a Pennsylvania crude petroleum was subjected to pressures of one, eleven and eighteen atmospheres at constant temperature of 700 deg. C. to form benzene and toluene.

The following table tabulates the analytical data:

	700 DEG. C.	One	Eleven	Eighteen
Atmospheres pressure				
Specific gravity recovered oil.....	0.891	0.970	0.998	
Per cent of recovered oil.....	13.3	25.0	18.0	
Per cent benzene in recovered oil.....	11.3	22.3	22.4	
Per cent of toluene in recovered oil.....	7.5	15.1	12.9	
Per cent of benzene on basis oil used for production .....	1.5	6.6	4.1	
Per cent of toluene on basis of oil used for production .....	1.0	3.8	2.3	

A paper on "Scrubbing Carburetted Water Gas" was presented by ROBERT J. MOORE and GUSTAV EGLOFF. This will be found elsewhere in this issue.

"The Deposition of Silver Films on Glass" was the subject of a paper by A. SILVERMAN and R. M. HOWE.

"Chars and other Decolorizing Agents" was the subject of a paper by CHARLES E. COATES. Dr. Coates found that by heating almost any form of carbon at a certain temperature in an electric furnace its decolorizing power was greatly increased in acid sugar solutions, and that a good decolorizing agent could be made from pine wood. He thought the decolorizing power of carbon was a function of the porosity and that this porosity was changed by heating.

Two papers, one on porcelain ware tests and on on glassware tests were read by C. E. WATERS. The authors of the latter paper were PERCY H. WALKER and F. W. SMITHER.

"Potash Recovery from Greensand" was described by H. W. CHARLTON. He showed samples of good quality brick made as a by-product from the manufacture of potash from greensand. He said greensand was a cheaper raw material than feldspar as it required no quarrying. The greensand is digested with lime and the solution filtered and evaporated. In order to produce 1 ton of  $K_2O$  per day about 30,000 bricks would have to be made but all kinds of tile and other materials can also be made. Mr. Charlton said the process would pay on a pre-war basis.

Julius Stieglitz in his presidential address delivered Wednesday evening said that chemistry is all that has saved Germany. He urged a high tariff on dyes and drugs, and said that manufacturers should share more profits with chemists.

#### Thursday's Session

At the Metallurgical Symposium Thursday morning, Dr. W. A. Whitaker, of the University of Kansas, Lawrence, presided. H. M. Boylston presented a paper on "Problems in the Metallography of Steel." Elwood Haynes presented a paper on "Stellite as a Substitute for Platinum." He said that it has the same melting point and is not attacked by nitric acid, that it can be used in the arts. I. P. Parkhurst presented a paper on "Effect of Annealing Steel on Its Electrical Resistance." E. R. Weidlein presented a paper on "Sulphur Dioxide in Hydrometallurgy." E. P. Mathewson presented a paper on "Importance of Flotation;" Dr. W. D. Bancroft, a paper on "The Theory of Froth;" O. C. Ralston, one on "Chemicals Used in Flotation," and Dr. W. A. Whitaker, one on "Flotation of Zinc Tailings."



## Rubber and the War

By Andrew H. King

If anything, rubber plays a more important part in the carrying on of modern warfare than it does in time of peace. War separates essentials from non-essentials, and in this way impresses upon our minds the importance of many commonplace things. Rubber is one of these. As a basic raw material it ranks next to iron. There is nothing else like it. It fills a place absolutely its own. It has no rivals. The combinations of strength, elasticity, and mobility in such wide variations are not to be found elsewhere in nature. It is firmly interwoven in our fabric of civilization.

Its influence has for the most part been constructive rather than destructive. Whether it be found in the hose of a city fire department or in the soldier's gas mask, it is a singular fact that its purpose seems to be the conservation of human life and comfort. War is the most destructive of the games humans play at. The labor of centuries is destroyed in a brief five minutes bombardment. Fortunes in shells are rained upon the enemy. An army will go to the greatest lengths to destroy enemy life and property, but it will go an equally great distance in the other direction to conserve and protect its own. This is the office of rubber. Wherever it is used it is always protecting something, keeping someone dry, shielding something from shock, conserving electrical power, preventing waste in a thousand different ways. It has done much to cushion this most brutal of games and to make it just a little more comfortable for those that play at it. We find it in every branch, and its work is always the same—conservation.

The biggest problem an army has to face is transportation.\* New stores of food and munitions are constantly required. Large bodies of men must be moved rapidly from place to place. This has always been a problem. Napoleon failed in Russia because his supply trains could not get through. The influence of the railroad is well known and understood. Suppose we turn to the automobile and see what it has done. We find the motor used extensively on the battlefields of Europe. It has been estimated that our Allies have now in actual service 300,000 motor vehicles. We find them carrying everything, wounded, food, munitions, reinforcements. The battle of the Marne was saved by men who arrived by Paris taxicabs.

But the success of motor vehicles would have been impossible without the rubber tire. Nothing else transmits the tractive force so well. Nothing else rides so easily, with so little jar as the pneumatic tire. In our own country our highways take on a new importance—or rather an old importance. They are becoming once more "arteries of commerce." Trucks of all sizes, many with trailers, ply between our cities. Recent freight congestions have proved their worth. It appears that the vexing problem of long and short haul rates is to be solved by forces outside the Interstate Commerce Commission, for the day is not far distant when the railroads will not take any short haul business whatever and will concentrate on the long hauls, in which field they seems to be most efficient. The short haul belongs to the truck. Already manufacturers and stores are pooling deliveries. It remains for a few en-

terprising and far-sighted men to establish regular common carrier service. But even the long haul field is not inviolate. Recently an Akron rubber company installed regular Akron to Boston service. The experiment must have been successful or the fleet would not have been increased to five trucks. The running time going and return is one week. The secret of this success seems to be in the tires. These are of special extra large and extra heavy pneumatic cord construction. They plow through sand and mud roads almost as easily as they run on brick. The ordinary solid truck tire would be helpless in roads they negotiate easily. The completion of the Lincoln Highway has given a decided impetus to touring. Here again we find the pneumatic cord tire giving the best service of any in the field.

In France motor trucks are used mainly for short hauls from the railroad base to the front. But in the campaigns against Serbia and Russia the Germans used them quite extensively on long hauls. The average life of a solid tire is seldom over 2000 miles, less than one-tenth of that expected under ordinary conditions. Bad roads, shell holes, shell fragments, overloading, speeding, and all sorts of hard service in all kinds of weather are responsible. Repairs shops are scattered along the various routes.

Our Council of National Defense has estimated that an army of a million men will require between 30,000 and 40,000 motor trucks. This figure is probably low. It is not unlikely that before the war is over our army will number fully 4,000,000 men, requiring perhaps 200,000 trucks. Pneumatic tired automobiles in ambulance service, officers' cars, and motor lorries transporting whole companies with extreme rapidity, will likely number fully 100,000 more. The load which this particular branch of the rubber industry will be called upon to bear will be very heavy indeed.

The dispatch rider of a half a century ago is gone. He and his noble steed "flecked with foam" have given place to a mud bespattered streak—the motorcycle. With all our other means of communication it is still necessary at times to send written instructions. These the motorcycle rider carries with incredible ease and swiftness, over the very worst of roads and into the veriest of hells. The wear and tear upon his tires is perhaps the worst of any. The number of machines now in service with our army is not known, but bids were recently requested for 10,000 more. This is doubtless just the beginning for it is recorded that in the British army alone there are 100,000 machines in service.



FIG. 1—A SUPPLY TRAIN SOMEWHERE IN FRANCE

Figs. 1 and 3 from *Scientific American*; Figs. 2 and 5 from *Saturday Evening Post*; Figs. 4, 6 and 7 from *India Rubber World*.



But the part of the motorcycle rider is not alone to carry dispatches. There are companies of motorcycle scouts who are able, by reason of their swiftness, to perform feats impossible for Early and Jeb Stuart. The machines are often equipped with side cars carrying machine guns, thus rendering them many times more effective.

Physicians have laid most of the ills to which the enlisted man is heir, to bacteria, filth and exposure. The first two are overcome by vaccination and cleanliness, and the third by rubber. Our military leaders fully realize that a man who is dry and warm can stand most anything and do most anything. There will be no more standing unprotected all day in water up to the waist for our soldiers. In the British army hip boots for trench wear are a most necessary part of each soldier's equipment. In our army every man has either a slicker or poncho which serves him both as a rain coat and a ground sheet. Two ponchos laced together make him a fairly comfortable shelter tent. The poncho of our Allies is their ground sheet with which each soldier is supplied. The loss of these articles by troops in action is very high. It was estimated eighteen months ago

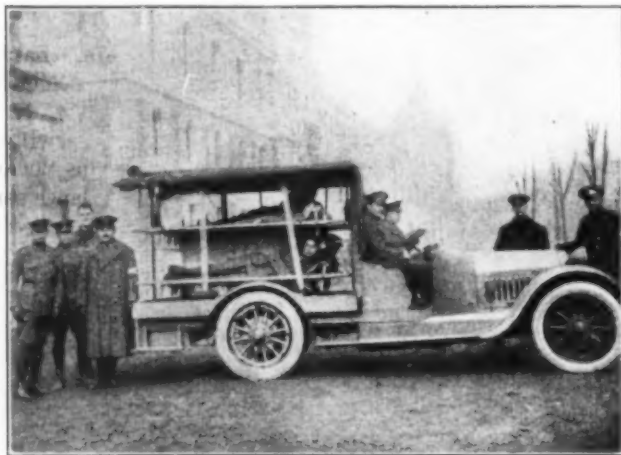


FIG. 2—AN AMERICAN AMBULANCE—UP TO THE MINUTE FOR COMFORT

that the total waste in rubber goods at the front reached fully 4000 tons daily.

Men in the motor truck service have rubber-proofed coats. Their machines are provided not only with rubberized tarpaulins but also with hoods which extend over and surround the driver's seat. Motorcycle riders are clad in a suit which is almost entirely rubber proofed. Ambulance drivers have rubber coats, boots and hats. Haversacks and knapsacks are also proofed with rubber.

This policy of protection from moisture is extended to nearly everything else. Light machine guns have their covers, as do also the delicate parts of the largest guns. Supplies of all kinds are properly protected by rubberized fabric. In this field alone rubber renders a most signal service.

The gas mask is but another illustration of the protecting nature of rubber. It has proved an effectual checkmate to German gas attacks. While a number of gases have been used it is now agreed that chlorine and phosgene are most often met with. The effects of chlorine have been known for many years, but the employment of phosgene was indeed a triumph for "frightful-

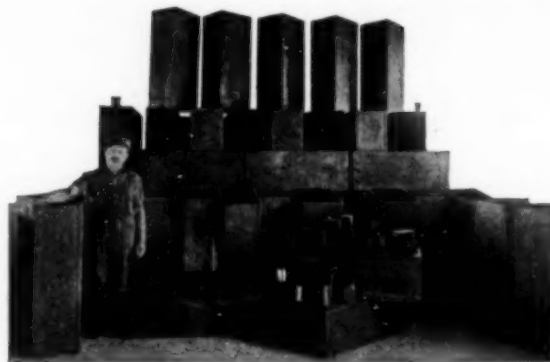
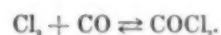


FIG. 4—BATTERY JARS FOR SUBMARINES

ness." This powerful and poisonous gas is known to the chemist as carbonyl chloride,  $\text{COCl}_2$ , and is produced by heating chlorine with carbon monoxide. The reaction follows:



It is a colorless gas condensing to a liquid below +8 deg. C. At 0 deg. C. its specific gravity is 1.432, which is only a little less than that of carbon tetrachloride whose gravity is given as 1.63. Phosgene in the vapor phase is very heavy and tenacious. It is many times as poisonous as carbon monoxide and acts in much the same way, by adding on to the hemoglobin of the red blood cells, preventing them from functioning as oxygen carriers.

The gas mask is constructed upon simple lines. The hood is made of rubberized fabric and fits the head rather snugly. The eyes look out through rather large celluloid windows. A spring clamp with soft rubber buttons on the tips is provided for closing the nose, for all breathing must be done through the mouth. Incoming air passes first through a little metal box which contains the purifying chemicals, then through a hose which is connected to a rubber bit similar to that of a football player's nose guard. This bit is held firmly between the teeth. When exhaling, a little flapper valve opens and allows communication with the outside air. The life of a gas mask is not long. The gases are extremely reactive, and it is a credit to rubber chemists that it offers any resistance whatever. The outfit is neat, easily carried, and as comfortable as one could expect. The trick of breathing through the mouth is a little hard to grow accustomed to, but this is readily learned.

Another field in which rubber has rendered signal service is in the air. Rubber, while not entirely satisfactory, is still the best material for coating cloth which is to resist the diffusion of hydrogen. The gas bag of balloons is made of two or three piles of a very closely

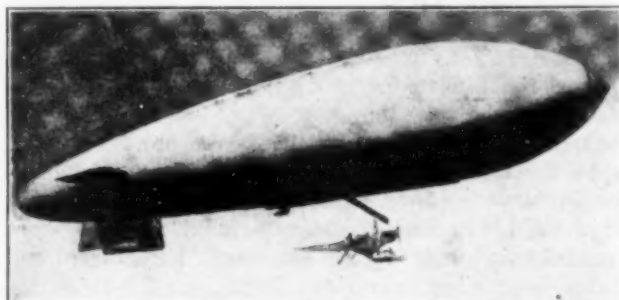


FIG. 3—A BRITISH BLIMP



FIG. 5—AN AEROPLANE IN FLIGHT (NOTE THE RUBBER TIRES)

woven and well proofed fabric. This proofing is applied by spreading machines on which the cloth receives a number of coats of rubber cement. The solvent is, of course, evaporated between coats.

Small captive balloons are used for observation purposes on sea and on land. With the advance in aeroplane practice it seems that their day is almost past.

This is not true, however, of the dirigible, called by our friends across the water "the blimp." Those building for our government have a gas bag shaped not unlike a great fish. Our first dirigible DN-1 is now fit only for training purposes. Its gas bag is 175 ft. long and has a maximum diameter of 35 ft.; 2500 ft. of double texture balloon fabric were used in its construction. Within the bag are located two balloonets, fore and aft. These interior gas bags are used in ascending and descending. To rise, the forward balloonet is emptied and the rear one pumped full of air. This disturbs the balance of the balloon, the nose is pointed up and it rises. To descend, the procedure is the same, but in

this case the forward balloonet is filled and the rear one emptied.

Sixteen dirigibles of a new type, modelled after the blimp of the British navy, were ordered by our government some months ago. It is understood that these are the first of a fleet of 300 which are to be used for coast patrol and search for enemy submarines. One of these recently made a trip from Chicago to Akron, about 400 miles, and covered the distance in sixteen hours. The advantage of a dirigible over an aeroplane as a submarine chaser lies in its lower speed. When its operators locate a U-boat, they can re-



FIG. 6—RUBBER SUIT FOR HYDROPLANE DRIVER

main right over the place where it submerges. They will doubtless be provided with bombing devices and machine guns so as to be able to hold their ground until the arrival of the mosquito fleet. An aeroplane travels so fast that it can only say where the submarine was, not where it is. The blimps have given very satisfactory service in the British navy.

In the makeup of an aeroplane, rubber plays no small part. The wings are covered with rubberized fabric to prevent them from taking up moisture which would be simply a dead load. A very superior grade of rubber hose conducts the gasoline from its reservoir to the engine. Other hose is provided at points where the wire stays would cross. The valuable and extremely delicate instruments are protected from moisture by rubber. The machine runs along the ground on rubber aeroplane tires. On these it gets up its initial speed for the flight. When it lands the shock is taken up partly by cleverly designed rubber bumpers and partly by the tires. The insulation, which is so important, is rubber. Both the driver and his observer are protected from the cold and dampness of the clouds by rubber suits, hoods, and gloves. An apparatus which allows them to breathe in a

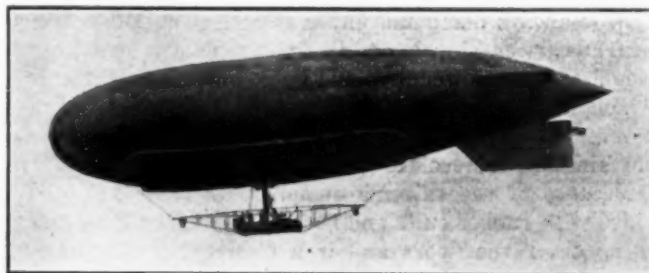


FIG. 7—LATE MODEL AMERICAN DIRIGIBLE

rarified atmosphere is of rubber. They are in communication with one another through rubber speaking tubes.

The hydroplane, because of its contact with the sea, must be still more carefully waterproofed. The driver wears a rubber life belt, and his oxygen outfit will permit him to remain submerged for thirty minutes should he have an accident.

A modern battleship has been likened to a small city. On it are practiced all the arts of peace and war. Rubber is a prime necessity. We find the usual mechanicals—many different kinds of hose, air, gas, water, steam, armored, etc.; valves, gaskets, packing, washers; all kinds of belting; bumpers, shock absorbers for the great guns; insulation of all kinds; hard rubber knobs and handles for switches; rubber tile, matting, and rubber tired trucks. It is a floating fortress of steel. Its joints must be well packed and tight under all conditions. All that may be said of the virtues of rubber in a peaceful city applies here. The men have their rubber proofed slickers, suits, and boots for duty in stormy weather. Here again the importance of keeping the man dry is fully realized. Guns and munitions must be protected from the salt air. Floating as it does in water, there is a constant battle to keep things dry. Without rubber it would be very difficult.

Every ship in the U. S. navy has one or more divers aboard. These men are called seaman gunners and diving forms but a part of their training. Their principal

service is to examine the hull of their vessel or to recover something or other that may have been lost into the sea. The modern diving dress is made up of two parts, the bronze helmet and collar, and the elastic suit. In dressing the diver gets into his suit through the neck. There are but three openings, one at the neck and one at each cuff. At the feet the dress is attached to the heavy shoes. The dress is made of the best rubber sheeting placed between two layers of tanned twill. The cuffs are closed tightly on the wrists by means of rubber rings. There is an inner and an outer collar. The outer one is pulled over the breast plate to form a water-tight joint. The helmet is screwed down upon his collar and made tight by a rubber gasket. The face plate is sealed in the same manner. The very best of hose is needed to supply him with air. It is hardly necessary to add that without rubber deep sea diving would be impossible.

In the building and operation of a submarine, rubber is of fundamental importance. It must be absolutely watertight and its packing and gaskets must be capable of resisting enormous pressures. Because of the necessity of running by electrical power while submerged the insulation problem is a big one. The interior of the boat is always damp and unless the wires and machines are adequately insulated disastrous short circuiting would result. Power is stored up in numerous batteries which must have their hard rubber jars. These are covered with sponge rubber slab to keep any electrolyte entrained in the evolved gases from leaving the jar.

Because of the extreme dampness the men are provided with rubber suits and boots. Rubber matting and tiling cover the floors and iron staircases. The periscope and other instruments are fitted with rubber bumpers and cases so as to protect both them and the operators from injury. In our navy the men are provided with rubber helmets for escape in case of accident. An important part of the torpedo is the rubber diaphragm by which its depth of submergence is regulated.

Our mosquito fleet consists of a rather large number of light fast boats which are more or less open. They must operate in all kinds of weather, consequently waterproofing and insulation are of primary importance.

Wherever electricity is used, insulated wire is necessary. Rubber insulation is still the most satisfactory material known. The best pliable insulation contains approximately 30 per cent of Hevea rubber. There are certain places, as for example, in the magneto of an aeroplane or automobile, where hard rubber insulation is highly desirable. The telegraph, telephone, and wireless telegraph are all of them dependent upon rubber for both hard and soft insulation. Electricians would be unable to handle high tension wires were it not for their rubber gloves.

In many steps of the manufacture of munitions rubber is called upon to protect the operator from serious injury. For example, in all the nitrating operations the men must be sheathed in rubber boots, aprons, and gloves. Again, a very small quantity of nitroglycerine causes an intense headache, and larger amounts may cause death. Rubber protection is absolutely necessary. When the munitions are completed rubber is called upon to keep them dry so that they may reach the field of battle in good condition. There are proofed bags for the powder and gun cotton, and rubber caps for shells.

The fine instruments, and modern warfare has developed a good many—the binoculars, telescopes, range finders, compasses, chronometers, etc., must all be kept dry. Hard rubber often forms an integral part of them, and it is not uncommon to see their leather cases enclosed in rubber.

In the work of mercy, the care of the wounded, rubber also has its place. The soldier's first aid kit contains among other things a rubber tourniquet. The stickiness of his adhesive tape is due to rubber. The wounded man rides to the hospital in an ambulance whose floor is covered with rubber tiling. Many times he will be wrapped in a rubber sheet. The surgeons and nurses who meet him are attired in rubber aprons and gloves. He lays on a rubber bed sheet and his wounds are held together with rubber bandages. If he has fever, a rubber ice cap will cool his head; if a chill it is a rubber hot water bottle which is placed at his feet. If his wounds are serious and deep rubber tubing will carry the sterilizing Carrel-Dakin solution. If he is confined long, a rubber ring or pad inflated with air will ease him and prevent bed sores. Hard rubber enters into the construction of his physician's instruments, his catheters and syringes.

Rubber enters largely into the construction of life-saving equipment. Sailors in the British navy are provided with rubber collars which can be inflated in time of need. Cork is perhaps the most dependable, but it is bulky. A rubber life belt can be kept in the pocket and inflated when necessary. Life rafts float because of long rubber-proofed bags stuffed with cork or kapok, a silky fiber of great buoyancy.

When German autocracy crumbles, as crumble it must, it will owe its fall to four serious mistakes, all of which are directly traceable to what the athlete knows as overtraining and what the boy of the street calls "big head." They are:

- (1) It thought Belgium would not fight.
- (2) It thought England would remain neutral and the seas would be open.
- (3) It took American patience for cowardice and decided we would not fight.
- (4) It failed to appreciate the importance of rubber and to have a sufficient store laid by. Conditions are now so bad in Germany that even the wounded must do without it.

The first three we are not concerned with here. The fourth is typical of an autocracy overtrained in its own egotism. It prepared for war so effectually that it forgot to also prepare for peace. Now the penalty for being a liar is to believe the lie yourself. German propaganda spread the lie of German invincibility throughout the world, but the German himself came to believe it and this mono-mania will lead to his undoing. Rubber is so primarily a material for peace that the War Lord failed to note its importance for war.

Historians tell us that we have had on this earth of ours a stone age, a copper age, a bronze age, an iron age, and a steel age. Civilization has advanced and side by side with it, the art of war. All these materials are of such a nature that they serve both for war and peace. They are both destructive and constructive. How different it is with rubber. Its influence is preponderantly protective. The rubber industry is just beginning. Does it not augur well that the rubber age which is to come will be an age of peace?



## The Mineral Industry—1892-1916

By G. A. Roush

Editor, The Mineral Industry

In glancing through the first volume of "The Mineral Industry" we find many statements and discussions that in the light of present day developments are very interesting and in some cases amusing, as no doubt many of the discussions of the present day will appear to the reader of a quarter of a century hence.\*

For example, attention is called to the enormous developments that had been made in the five or six years preceding in the metallurgy of aluminium, emphasizing the fact that the price of the metal had been brought down to as low as 50 cts. per lb. and the production for the year, in the United States, was almost 300,000 lb., and the world's production almost 500 metric tons. The article closes with the statement, "It is doubtful if the further prosecution of the electrical methods, by which alone aluminium is now made, will bring the cost of it to the point at which it will become a prominent metal, unless they proceed along the line of direct reduction. Even here it is by no means certain that they can make it cheap enough. . . . While the electrical reduction methods are not to be condemned, those who seek by other means to make cheaper aluminium should be encouraged." Compare this with present conditions, with a United States production of 63,000 metric tons, a world's production of 132,500 tons and a production cost that has been estimated as low as 10 cts. per lb.

It is interesting to note that the coal production in the United States to-day is equal to the world's production as reported in 1892. The United States was then second in production with Great Britain leading, while the United States now leads with a production almost equal to the combined production of her two nearest competitors, Great Britain and Germany.

\*The material of this article has been taken by permission from advance sheets of Mineral Industry during 1916.

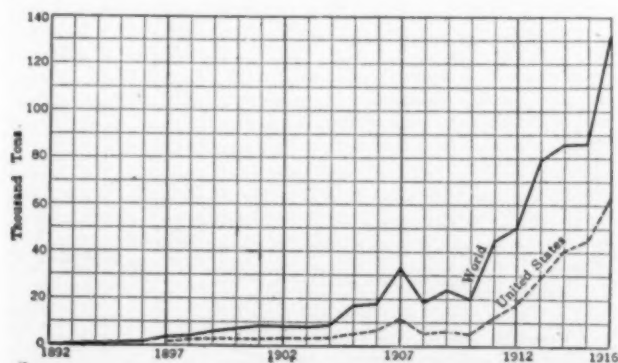


FIG. 1—ALUMINIUM PRODUCTION

These two for several years past have ranked very close together, with Great Britain slightly in the lead, while 25 years ago Great Britain's production was double that of Germany. Although these three great producers have changed order in the tables and have all seen enormous increases of production of from nearly 100 to over 300 per cent in the course of 25 years, the production of all three still bears almost exactly the same ratio to the world's production, namely, slightly over 80 per cent of the total.

During the period under review the world's copper production has more than trebled, while the production of the United States has increased to six times its former amount. The United States has always led in production, but during that time has increased from 45 per cent to almost 65 per cent of the total. Twenty-five years ago Spain and Portugal came second, Chile third, Japan fourth and Germany fifth; the order now stands Japan second, Chile third, Mexico fourth, Canada fifth.

With gold and silver the figures are no less interesting. The gold production of the world has quadrupled while that of the United States has trebled. Twenty-five years ago the order of production was United States, Australia, Russia, Africa. At present it is Africa, United States, Australia, Russia. The African production, due to the enormous developments on the Rand, has increased to over 14 times its previous value, and now leads with about double the production of the United States, its nearest competitor.

The silver, up to 1911, had increased about 60 per cent, but in the last five years there has been a rapid decline, due to the revolutionary activities in Mexico,

the heaviest producer, so that at present the production stands only about 10 per cent higher than 25 years ago. Since the price has dropped faster than the production increased, the world's production of silver in 1915 was worth only about one-half as much as the production of 25 years ago. The rise of prices during the



*G. A. Roush*

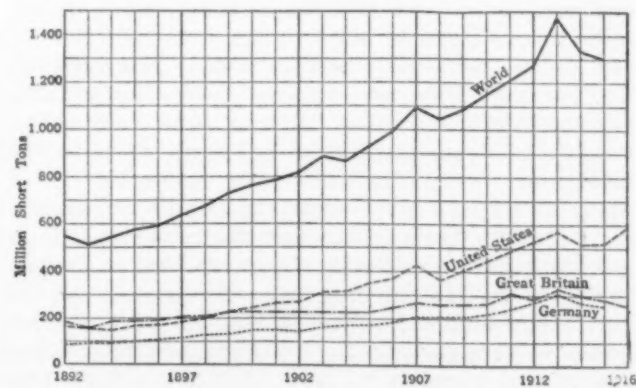


FIG. 2—COAL PRODUCTION

last year will, however, partly eliminate this discrepancy in value, and will reduce the deficiency in value from 50 to about 35 per cent. The United States started with a lead of 50 per cent over Mexico, the holder of second place, and ended with a production about double that of Mexico; but from 1902 to 1912 the Mexican production considerably exceeded that of the United States. The latter has shown an increase of about one-eighth, while Mexico has suffered such a decline as not only to wipe out the heavy lead with which she had held first place for 10 years, but has even pulled her considerably below her production of 25 years ago. Formerly Bolivia held third place, and Australia fourth. Mexico's position in second place is now being threatened by Canada, which formerly was far down the list, while Peru holds fourth place, and Australia has dropped behind Japan and Spain.

The production of iron ore in the United States now is about four times the production of a quarter of a century ago, and the pig-iron production has increased

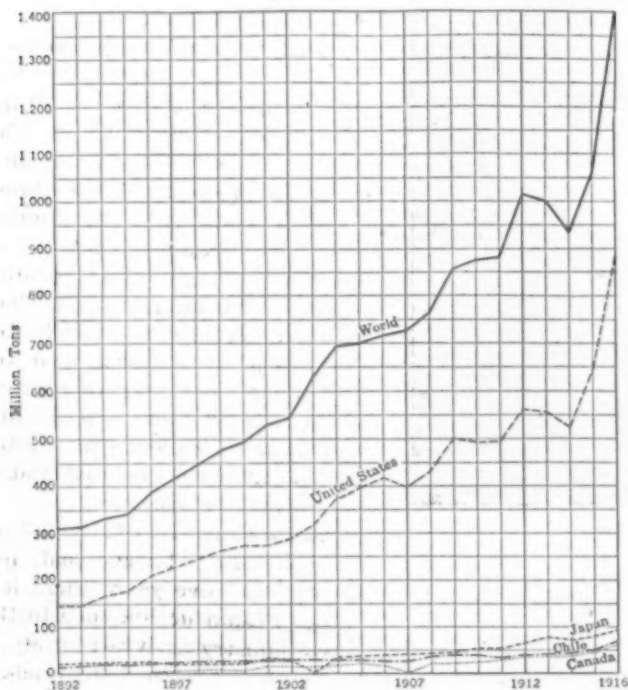


FIG. 3—COPPER PRODUCTION

in about the same ratio, while the pig-iron production of the world has increased to about three times its former amount. The order of producers is now United States, Germany, Great Britain, France, and Russia, with Austria-Hungary and Belgium practically tied for last place in the list of producers of more than 1,000,000 tons per year. The previous ranking was United States, Great Britain, Germany, France, Austria-Hungary, Russia and Belgium, with the last three all below the million-ton mark. Pig-iron production in the United States to-day is at a rate approximately a third greater than that for the entire world 25 years ago. It is true that the United States was in the lead in production then, but Great Britain was a close second, and the German production was over 50 per cent of the United States production. To-day the United States production is approximately 50 per cent of the world's production, or, in other words, is equal to that of all the rest of the world put together.

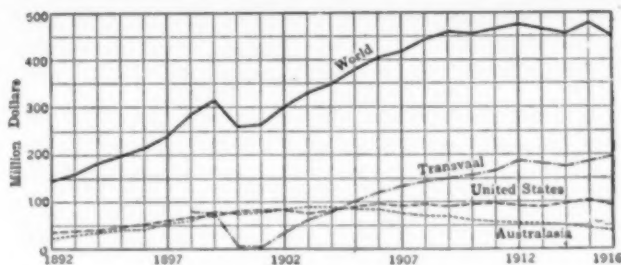


FIG. 4—GOLD PRODUCTION

The steel production naturally follows closely the production of pig-iron, and the order of production for the various countries is the same for steel as for pig iron, both at the beginning and end of the period under review. Due, however, to the development of processes which permit the use of greater proportions of scrap and waste material in the manufacture of the steel, and to the development of processes with higher percentage yields of finished steel on the raw material used, the total production of steel has grown faster than that of pig iron, and is now over five times what it was 25 years ago. And where the United States produced only a little over one-fourth of the former total, it now produces half, and the production of the United States has increased eight-fold.

During this period the processes used in the manufacture of steel have undergone a remarkable transformation. In 1892 almost 84 per cent of the steel production of the United States was made in the Bessemer converter, and 14 per cent in the open-hearth furnace. The corresponding proportions to-day are 26 per cent in the converter and 74 per cent in the open-hearth.

Lead production in the world during the past 25 years has approximately doubled. The ranking of producers at present is: United States, Spain, Germany, Australia and Mexico, all normally producing over 100,000 tons annually, but this figure has not been reached in Mexico during the last few years on account of the curtailment of production due to revolutionary activities. The former order of producers was the same as at present, except that Mexico was ahead of Australia. The heaviest increase was in the United States, amounting to about 260 per cent.

The enormous developments in the steel industry have demanded a proportionate increase in manganese production. The world's production is now about seven or eight times what it was 25 years ago, and there are

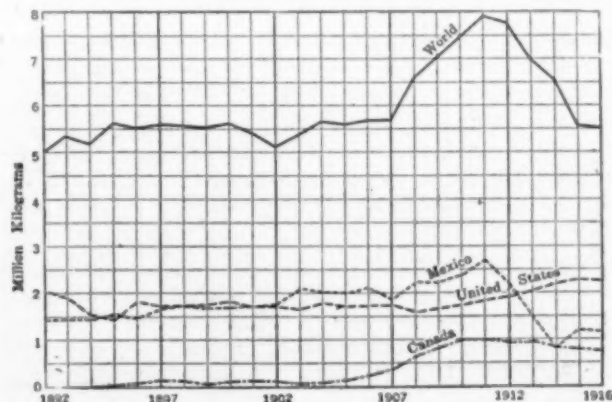


FIG. 5—SILVER PRODUCTION



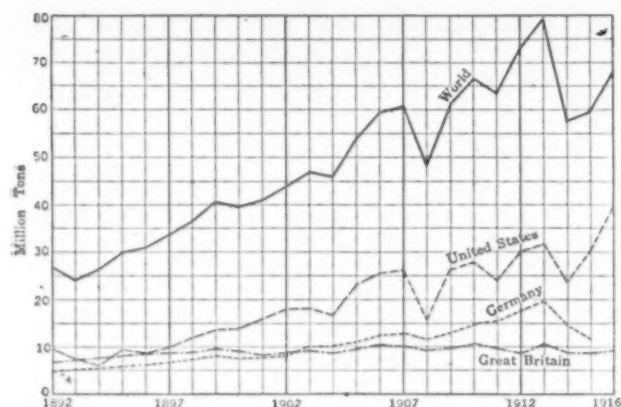


FIG. 6—PIG-IRON PRODUCTION

now three countries, India, Russia and the United States, with productions ranging from two to three times the world's production of 25 years ago.

The petroleum production of the world during the period has increased five-fold. In 1892 the producers showing more than 1,000,000 bbl. per year were the United States and Russia, together accounting for 97 per cent of the world's production. The present producers of more than 1,000,000 bbl. per year are, in order of production, United States, Russia, Mexico, Dutch East Indies, Roumania, Galicia, India, Peru, and Japan. The United States now contributes 64 per cent of the world's production, as against 57 per cent 25 years ago, and now stands at about six times its former production. The Dutch East Indies, Peru, Argentina, Trinidad, Mexico and Egypt have entered the field as large producers during the period and now account for one-eighth of the total production.

The world's sulphur production is obtained almost entirely from Italy and the United States, with smaller amounts from Japan and Spain. Twenty-five years ago Italy was the producer of over 90 per cent of the world's supply, with most of the remainder coming from Japan. Consumption was on the increase, and the Italian production grew rapidly, reaching a maximum in 1905, when the production was nearly double that of 1892. Production in quantity in the United States began in 1903 and this soon reacted on the Italian production, which declined to about 50 per cent of the total.

Sulphur production during the 25 years has doubled, but pyrite production has more than trebled. Formerly France led in production, followed by Portugal, Germany, United States and Spain, all producing over 100,000 tons annually. The producers of that quantity

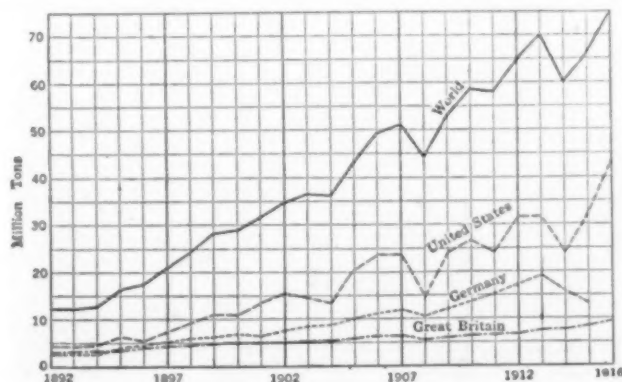


FIG. 7—STEEL PRODUCTION

at present are as follows: Spain, Norway, Portugal, United States, Italy, France, Germany, Canada, Russia, Japan and Hungary. Of all, Spain has shown the greatest increase, with Norway second. The Spanish production has jumped from 10 per cent of the total to nearly 25 per cent, and the Norwegian from 6 per cent to double that proportion. The United States production has just about kept pace with the total production.

The tin production of the world has, in the quarter of a century, almost doubled. Malaya still contributes a large share of the total, but has dropped from over 50 per cent almost to 40 per cent. England long held second place, but now Bolivia takes it with almost 20 per cent of the total, where formerly she was at the end of the list with 3 per cent. Banka still retains third place, having increased somewhat more rapidly than the totals. Australia and Billiton have both declined, the former the more seriously.

Tungsten is a metal that has seen almost its entire commercial growth within the period under review, and most of that within the last few years. The production of tungsten ores in this time has increased in a ratio of almost 50 to 1, two-thirds of which has been within the last five years. In the present production the United States accounts for 35 per cent of the total, Burma 22 per cent, Portugal 8 per cent, Australia 7 per cent, and Japan 6 per cent, all producing over 1000 tons annually.

Zinc production in the past 25 years has about trebled. Most of the leading zinc producing countries have been disturbed by the war to such an extent that recent figures are not available for comparison, but from the latest data available the United States was

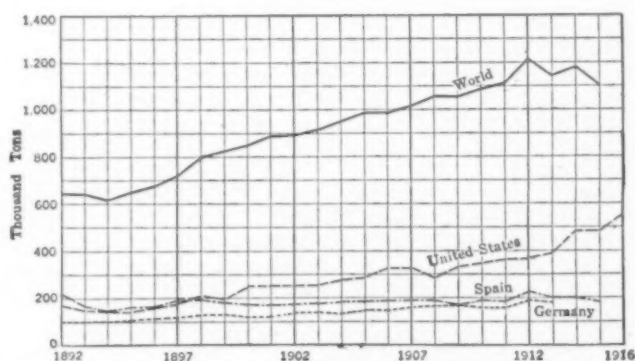


FIG. 8—LEAD PRODUCTION

the leading producer with Germany second, Belgium third, France fourth and Great Britain fifth. The former order was Germany, Belgium, United States, Great Britain, France. The United States has increased its production to eight times its former amount, and has increased its proportion of the world's output from 20 per cent to about 60 per cent.

It is of course absolutely impossible to make anything like a direct comparison between conditions now and twenty-five years ago, because now everything is on an abnormal basis. Some industries are swelled to beyond all semblance of their normal proportions by the extraordinary demands of war, while others are severely handicapped because of the disturbance of raw materials and markets, and the serious difficulties encountered in shipping, difficulties which are not by any means confined to trade with belligerent countries, but

extend also to the neutral countries and, in a large measure, to purely domestic shipping as well. However, in spite of all of the necessary readjustments, the period of the war has been, to most of the mineral and metallurgical industries, one of unparalleled prosperity. This is particularly true with aluminium, copper, iron and steel, tungsten, and zinc, which on this account have come to be classed under the heading of "war metals."

#### FUTURE DEVELOPMENTS AND INTERNATIONAL RELATIONS

What is in store for the future is difficult to foresee, but whatever may be the eventual outcome of the present conflict, it seems certain that the mineral and metallurgical industries will be called on to continue production to their utmost capacities in the work of restoration, and this will extend over a period of several years. It is to be expected that there will be somewhat of a slackening in speed after the conclusion of the war, for, however pressing may be her needs, Peace can never be the exacting taskmaster that War is; this slackening will be simply a logical outcome of the conditions, but it should not be of such proportions as to cause a serious slump in any industry as soon as the war demands are satisfied. On the contrary, manufacturing plants will be able to relax from the strain of war production and settle down to the fulfillment of the demands of peace and reconstruction at practically their normal capacity at the time. Of course it is not going to be possible after the war to keep the production curves of the various materials rising at the precipitous angle they have assumed during the war, for demand in many lines now is far above normal and is still increasing, but the normal course of the world's progress will soon bring it to a point where it can absorb these enormous productions, and it is quite possible that the demands of reconstruction will absorb the excess over a sufficient period of time to permit this condition to be realized, so that at the worst all the industries will suffer will be a period of a few years with little or no increase beyond the point at which they were at the close of the war, rather than a serious break in production and values.

The titanic forces of the present struggle are rapidly bringing to a head many conditions that normally would have required years of slow development. New industries are born over night and grow to a real semblance of maturity in weeks instead of years. Plant productions increase by leaps and bounds, doubling and trebling within the year under the impetus of an all-absorbing demand and an unprecedented price. New machinery and processes are developed and invention is stimulated in all branches of industry.

Since the opening of the European war the latter part of July, 1914, with its accompanying commercial

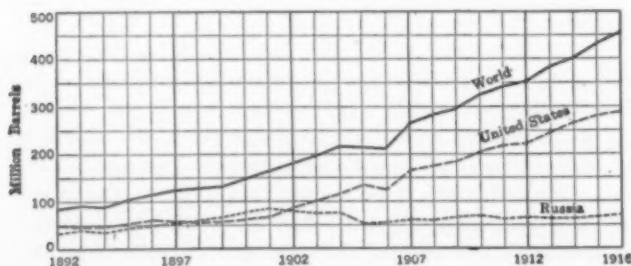


FIG. 9—PETROLEUM PRODUCTION

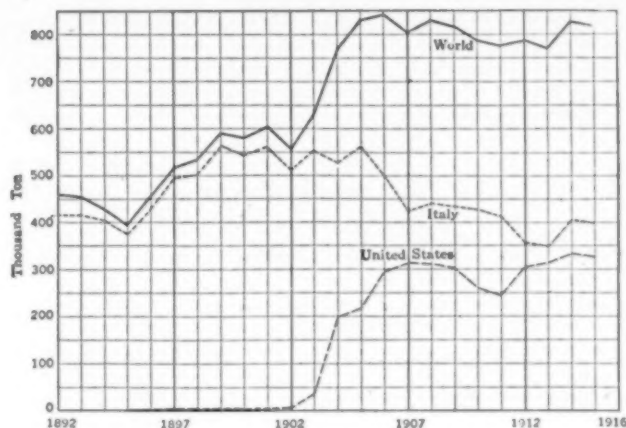


FIG. 10—SULPHUR PRODUCTION

disturbances, there has been a great deal of discussion in this country concerning the possibility of making the United States independent of foreign supplies in order to avoid future difficulties of this kind. This, of course, does not mean that all imports are to be discontinued, but that attempts be made to furnish domestic supplies of basic materials, in order that a whole industry may not be handicapped by the lack of some one material on which the process of manufacture depends. On analysis, however, this proposition does not prove to be as simple as it seems on the surface, particularly with regard to the mineral industry, either for the United States or for any other country. And, naturally, the smaller the country concerned and the more limited her resources, the more remote does any such possibility become. The discussion as here outlined is from the particular standpoint of the United States, but the arguments apply equally well, in a general way, to any of the other large mineral producing countries.

It follows from the natural course of human life and its needs that certain industries should be fundamental, and others secondary—or, in other words, that certain basic industries are concerned with the supplying of the prime necessities of life in their crudest forms, while the other industries are concerned with the modification of these crude forms through various stages of higher refinement, or with modifications of form, location, etc. Of these basic industries, probably none is more widely scattered over the face of the earth, more closely related to the general welfare and progress of the countries concerned and, in fact, more thoroughly universal than the mineral industry, with the

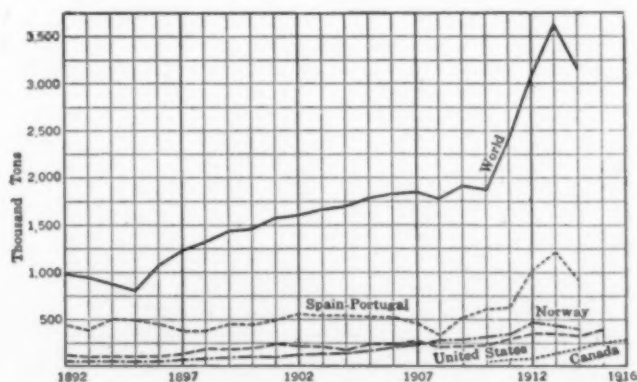


FIG. 11—PYRITE PRODUCTION



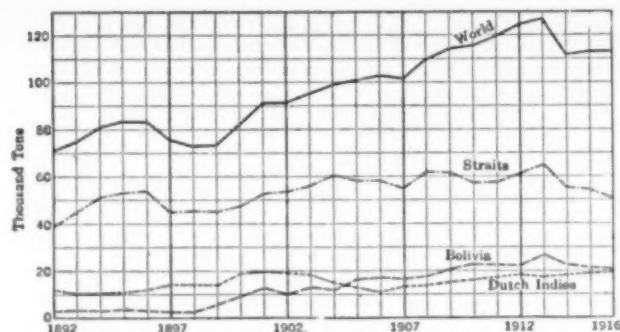


FIG. 12—TIN PRODUCTION

single exception of agriculture. In no other industry is the influence of a single locality so widely felt as in the mineral industry. For years the world went to Ceylon for its graphite, to Sicily for its sulphur, to the Ural Mountains for its platinum. A small district in the State of Arkansas furnishes the raw material for 65 per cent of the world's supply of aluminium. Chile furnishes practically the entire world's supply of sodium nitrate and Germany has supplied such a large proportion of the world's supply of potash, that the limitations of production and exportation resulting from the disturbances of war have made a shortage of this most necessary material throughout almost the entire world. And carrying things to the opposite extreme, it requires almost a page to list the countries that produce important quantities of the ores of gold, silver, copper or iron.

Probably every country and every state on the face of the globe has within its borders valuable mineral resources of one kind or another, of greater or less importance. In many cases it is something that is merely of local interest and importance; in other cases, such as those mentioned above, the materials are of in-

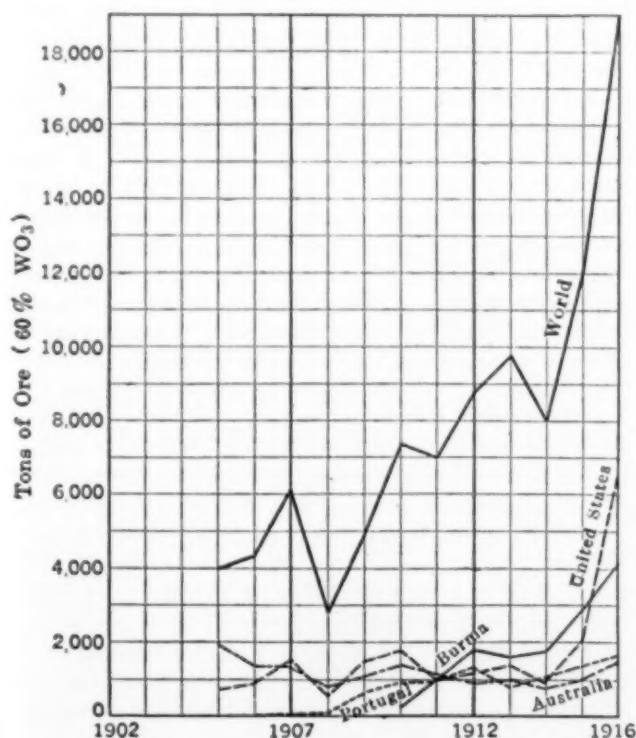


FIG. 13—TUNGSTEN PRODUCTION

ternational importance. Dana classes ice as a mineral, but its use purely as a mineral substance is probably limited to its employment as a building material in the arctic regions. Southern Indiana's Bedford limestone and Vermont's granite, however, while used for the same purpose, are naturally of incomparably wider application and value. When the production and use of any material is purely a matter of local interest, any knowledge or information concerning the industry involved in the production is also merely of local interest. But just as the breadth of the market and the scope of application of any material increases, so does the demand for information in regard to that material increase. The more general is the demand for the material itself, the more general is the demand for knowledge concerning the progress of the industries producing this same material in other localities, and on this demand for knowledge there can be placed no final limitation except one of degree. Other factors, geographical or political, economic or social, are contributive, rather than determinative.

The Arizona copper producer is interested more in the Montana production than in that of Utah, not because it comes from Montana, but because it is a heavier competitor in his market; but should the Utah production exceed that of Montana, Arizona's interest would follow the heavier producer, rather than remain in a given locality. Europe is interested in the Chilean copper developments, not because they are in Chile, but because they promise an additional amount of metal available for import into Europe, and the interest would be just as great if the deposits were in Fiji or Greenland.

As Kipling says, "The Colonel's lady and Julia O'Grady are sisters under skin." The laborer, the superintendent, the general manager, the New York capitalist, all have the same general interest, differing only in intensity and extent, depending on the contributing factors. The laborer makes his living from his work in the mines or smelter, and wants to know how things compare in the mine where he works and in the other mines in the neighborhood. The superintendent compares conditions in his own working district with the adjoining districts. The general manager in charge of plants in different parts of the country will consider matters on a still broader scope, and the capitalist will compare his holdings in this country with those in other countries. And so we have in every case, from whatever angle the question may be considered, an interest proportioned to the extent to which the individual is affected by the conditions within his own particular field of operations, as compared with other fields of similar work.

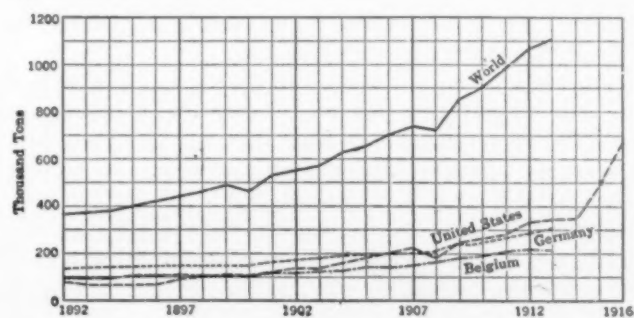


FIG. 14—ZINC PRODUCTION

The general interest thus manifested and the demand thus created for knowledge of the progress of an industry in different localities is inseparably linked with the economic dependence of each country of the world on most of the other countries. That stage of civilization when the world was made up of a number of independent districts is long past. A given locality can no longer produce within its own confines everything that is demanded in the course of its life. In the first place, civilization has reached a point where it demands more than it has in the past, and in the second place, economic development and the law of the survival of the fittest has led to an age of constantly increasing specialization, which, aided by increasing ease of communication and transportation, has brought things to a point where we now find ourselves dependent for one thing or another on almost every district of the civilized world.

This dependence can be well illustrated as the average man looks around his own home. He no longer lives in a house of his own building, eats food of his own growing, cooked in vessels of his own making, and wears clothes of his own weaving. In the average man's house we now see aluminium which probably originated in Arkansas, or possibly in France, and which, in the course of manufacture demanded cryolite from Greenland. He reads a newspaper printed from type containing lead from Missouri, Idaho, Utah or Mexico, and antimony from China. The asbestos pads on the kitchen stove came from Canada, and the polish on the stove from Korea, or possibly from Ceylon or Madagascar. The street in front of the house is paved with asphalt from Trinidad. The house is painted with barium from Germany. He frequently uses as a medicine iodine from Chile and bismuth from Bolivia. Such steel as he uses comes mostly from the United States, but the furnace in which it was made required magnesite from Austria or Greece, and as the steel came from the furnace it was deoxidized with manganese from Russia, India or Brazil. To make his stove bright and cheerful it is given windows which are glazed with mica from Canada or India. He gets his light at night from gas mantles made from monazite from Brazil or from electric globes, the tungsten filaments of which may have originated in the United States, but which are just as likely to have come from Burma or Bolivia. He uses nickel from Canada and tin from Bolivia or Malaya. He fertilizes his lawn and garden with nitrate from Chile and potash from Germany. His wife cherishes an engagement ring bearing a tiny diamond from South Africa, set in platinum from Russia, and dreams of some time having a necklace of "real pearls" from the South Sea Islands. They eat off china from Germany, with silverware that might have come from almost anywhere, and after dinner he smokes a cigar that he fondly thinks came from Havana.

So close is this association of the various countries in a commercial way, that any factor that disturbs one country will disturb several, through its commercial relations with the others, and anything that disturbs several will disturb practically all. An indication of this condition is the unanimity with which the contributors to the technical press mention the effects of the present European war on the various industries that they happen to be discussing. Almost without exception, these industries have been considerably affected

by the war. Some have been stimulated and some have been retarded and disorganized, but very few have remained unaffected.

These two factors, the individual interest in other localities supporting a given industry, and the interdependence of the various countries on each other for adequate supplies of certain materials, make necessary the dissemination of general information in regard to the status of the various industries from time to time. There are in the various states and countries certain organized agencies for the collection and distribution of such information, and the technical press gives a large amount of general information along these lines. But there is still room for considerable expansion along this line. Information should be fuller and more detailed, and should be made available more promptly.

It is not to be expected with the present broad development of all the various industries that any country of importance can become entirely independent of others in the matter of mineral production. It is possible to become partly so by the fullest development of the domestic resources, but absolute independence is impossible, because no one country, not even the United States nor Great Britain, with all her colonial possessions, includes within its boundaries *all* of the almost infinite varieties of mineral products that are now demanded by our every-day life.

#### PERSONAL CO-OPERATION

The prime requirement for the best development of domestic resources is a thorough knowledge of those resources. And for the best results, this knowledge must be well disseminated and not be confined to a few people in the immediate locality. In other words, every available source of material should be thoroughly advertised—not necessarily by paid advertising—but by proper publicity in the technical press, in order that the information may be readily available to all who are interested. This condition is at present only partly fulfilled, and there is room for considerable improvement.

And next in importance after a thorough knowledge of domestic conditions, is an equally thorough knowledge concerning the various foreign sources of any given material. This is, of course, more difficult to secure, and information is not nearly so plentiful as for domestic conditions and usually the more remote the locality the more meager is the information. Many of the disturbances of the past three years in foreign supplies of materials would doubtless have been considerably lessened if importers had had a fuller knowledge of sources of materials. Too many had no information beyond their own particular source of supply. And in many cases the necessary information was very hard to secure.

All the evidence, then, points to the necessity of fuller information concerning both foreign and domestic supplies of materials. And since it seems impossible for any country to be minerally independent, let each at least exert a reasonable degree of care in the apportionment of its dependence, for the strain can be considerably lessened for all by a proper exchange of information. To this end, co-operation between the various agencies interested in the collection and dissemination of such information is to be encouraged and fostered to the utmost possible degree.



## An Experiment in Scrubbing Carburetted Water Gas for Recovering Aromatics\*

Robert J. Moore and Gustav Egloff

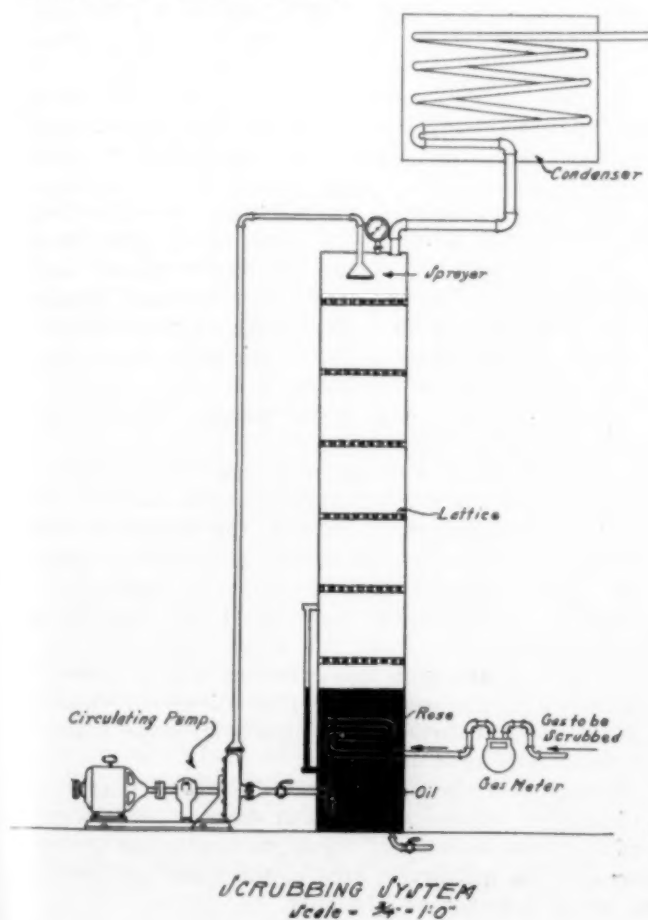
Considerable prominence has recently been given to the discussion of scrubbing carburetted water gas with a view to combating the shortage of toluene and benzene. The report, dated July 20, of Dr. W. H. Nichols, chairman of the Committee on Chemicals of the Council of National Defense, emphasizes the toluene shortage, and says that "efforts are going to be made immediately to increase this supply by 'stripping' the gas in large cities." In view of these facts the writers are of the opinion that the following experiment in scrubbing a representative water gas will be of interest to the oil fraternity.

### EXPERIMENTAL

The carburetted water gas fresh from superheater was measured by passing through a dry meter and thence into an 18-in. diameter pipe 10 ft. in height (see diagram). In this pipe 25 gal. of technical paraffin "straw" oil was utilized for the scrubbing of the gas, which passed below the surface of the oil through a rose. As the gas passed through, the oil was circulated by means of a pump and sprayed over a series of lattice woodwork set within the pipe by means of supports. This circulation and spraying of the scrubbing oil facilitated the solution of the light oil molecules in the gas. Above the scrubber a condenser coil and box was placed so as to minimize the scrubbing oil losses.

Twenty-five gallons of straw oil were used in a

\*Presented at the fifty-fifth meeting of the American Chemical Society, Boston, Sept. 11-13, 1917.



charge. When 1000 cu. ft. of gas had passed through the system, the benzolized oil was transferred to a one-barrel still (42 gal. capacity), with adequate steam and condensing arrangements. This oil was steam and gentle direct-fire distilled until a temperature of 175 deg. to 180 deg. C. was reached in the oil vapor line. At this temperature practically all of the light oil distilled off. This fact was carefully checked by analysis of the original straw oil and the debenzolized straw oil as shown in the following tables.

TABLE 1  
ANALYSIS OF ORIGINAL STRAW OIL  
Distillations in standard Engler 100 c.c. flask at rate of 2 drops per second  
Specific gravity 0.848/15.5 deg. C.

Temperature, Deg. C.	Per Cent by Volume 1st drop	Specific Gravity 15.5 Deg. C.
310 to 316	6.1	0.829
325 to 325	60.4	0.845
350 to 375	21.5	0.852
375 to 392	8.0	0.854
392 cracking	....	....

TABLE 2  
ANALYSIS OF OIL AFTER STEAM DISTILLATION  
Specific gravity 0.628/15.5 Deg. C.

Temperature, Deg. C.	Per Cent by Volume 1st drop	Specific Gravity 15.5 Deg. C.
306 to 325	9.7	0.833
325 to 350	55.0	0.844
350 to 375	18.7	0.851
375 to 389	10.0	0.855
389 cracking	....	....

Comparing tables 1 and 2 no greater variation is found than one usually finds in oil distillation by the Engler method, showing that all the light oil present after the scrubbing was removed by the steam and direct-fire distillation. Some loss of the straw oil occurred in operation, but all the light oil was recovered, as far as practicable, the conditions of the experiment approximating plant conditions.

### LIGHT OIL RECOVERED

The light oil recovered was 1.211 liters per 1000 cu. ft. of carburetted water gas washed. This oil was yellow and had the characteristic odor of a cracked oil. Its unsaturated content was high, 35 per cent combining with 1.84 specific gravity sulphuric acid. Due to this high percentage it was necessary to control the velocity of sulphonation by cooling to zero degrees due to the considerable heat generated by the interaction in order to avoid loss of aromatics, either by evaporation or by combination at higher temperatures. The analysis of the light oil is given in table 3.

TABLE 3.  
DISTILLATION ANALYSIS OF LIGHT OIL.  
Specific gravity 0.868/15.5 deg. C.

Temperature, Deg. C.	Per Cent by Volume 1st drop	Specific Gravity
39 to 75	3.8	....
75 to 100	55.2	0.867
100 to 125	24.9	0.869
125 to 150	5.9	0.868
150 to 175	1.0	....
175 to 200	0.8	....
200 to 225	1.1	....
225 to 250	0.1	....
250 to 300	0.7	....
300 to 325	1.4	....
325 to 350	4.0	0.831
Residue	1.0	....
Loss	0.5	....

In the above table the 6 to 7 per cent distilling at the higher temperatures is probably due to straw oil carried over during steam distillation.

The per cent by volume of the benzene, toluene and xylene cuts from the light oil are given below in table 4, together with the gravities and also the amounts of unsaturateds in each cut.

TABLE 4.

PERCENTAGE OF BENZENE, TOLUENE AND XYLENE CUTS AND UNSATURATEDS IN THESE CUTS.

Cut, Deg. C.	Per Cent by Volume	Specific Gravity	Per Cent of Unsaturated
Benzene (to 95) .....	51.8	0.866	46.0
Toluene (95 to 120) .....	24.1	0.869	18.0
Xylene (120 to 150) .....	6.0	0.868	24.0

This high per cent of olefins (table 4) formed in carburetted water gas as manufactured in the standard plants to-day would naturally be a retarding influence on the success of the scrubbing process, involving as it does a complicated low-temperature washing system and purifying of the aromatics with the losses attendant thereto. Therefore it may be feasible to adopt certain modifications in the water gas works with a view to decreasing the percentage of olefins formed. There has been much research along these lines, but little actual installation. The method of admixing to the blue water gas, hydrogen gas in order to decrease unsaturation has been shown by Whitaker and Leslie<sup>1</sup> to be of little use so far as the above problem is concerned, since their work indicates that low molecular weight olefins are not hydrogenated to any extent. Whitaker and Rittman<sup>2</sup> show the results of gas making under increased and decreased pressure, while Egloff and Twomey<sup>3</sup> find that cracking a gas oil at higher temperatures than usual effects a decrease in the per cent of olefins and increases the aromatic formation. It seems to the authors that in view of the necessity of obtaining toluene and benzene in larger quantities than now possible certain changes may be advisedly made in the water-gas machine involving either temperature, pressure or admixed gases so as to increase the yield of the above-mentioned by-products. Carrying out the preparation of the blue water gas independently of the cracking of the oil in the carburettor and mixing these products later may be a solution of the problem. Since the carburetor then is in a separate system, either increased or decreased pressure may be used in cracking as desired. Such changes may be feasible in view of the propaganda to change the gas standard from an illuminating basis to a heat unit. Or the benzene fraction with its high olefin content may be returned to the gas depriving the latter of only its toluene and xylene.

## YIELDS OF AROMATICS FROM THE LIGHT OIL

To determine the percentage yields of benzene, toluene and xylene actually obtainable from the light oil obtained by scrubbing, 1 liter was carefully treated with sulphuric acid, neutralized with sodium hydroxide, washed with water and dried over fused calcium chloride. This dried oil was distilled in an efficient fractionating column and analyzed by a method already described.<sup>4</sup> The results were as follows:

	Per Cent by Volume
Benzene .....	22.1
Toluene .....	20.0
Xylene .....	5.1

## THE VOLUME OF AROMATICS RECOVERABLE FROM 1000 CU. FT. OF GAS

Since the volume of light oil recovered from 1000

cu. ft. of carburetted water gas was 1.211 liters, or 0.032 gal., and the percentages of benzene, toluene and xylene are as given above, the volumes of these aromatics per 1000 cu. ft. of gas are as given below in table 5.

TABLE 5.

BENZENE, TOLUENE AND XYLENE RECOVERABLE FROM 1000 CU. FT. GAS

	Liters	Gallons
Benzene .....	0.267	0.0707
Toluene .....	0.242	0.0640
Xylene .....	0.062	0.0163

In view of the fact that the annual production of carburetted water gas is in the neighborhood of 150 billion cubic feet the above figures are significant.

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## The Resilience Test

By Henry M. Howe

A given specimen of steel, though ductile under common static tensile test, may be extremely brittle under the impact test of the Fremont type, Fig. 1, in which a nicked test piece, A, lying level and supported at both ends, is struck a sharp blow in the middle of its length by a falling ram, B.

It is certainly disquieting to learn that a form of brittleness exists which our present reception test, the static tensile test, cannot detect. It is of course possible that this form of brittleness cannot lead to failure under service conditions, but this is certainly far from self-evident. Indeed, the natural presumption is that it may lead to failure, and that, in not attempting to detect it, we put ourselves in the position of the cashier who, though knowing that the market is flooded with detectable counterfeits, takes no efficient steps to detect them, but accepts all deposits at their face value.

I believe that the present evidence goes far to prove that the static tensile test does not and cannot determine the fitness of material for resisting shock when in pieces which are threaded, nicked, or of equivalent abrupt change of section, and hence that for such services this test should be supplemented by an impact test.

When we reach this point, we find ourselves confronted with a very difficult choice between various tests, carried out under radically different conditions.

Before taking these up let us agree on our terms. Here are those which I propose:

*Resilience* is now used as the measure of the work done in breaking the test piece by a shock test. It is the product of the average resistance to deformation up to rupture into the deformation before rupture, and thus it corresponds in a sense to the product of the tensile strength into the elongation of the static tensile test. It is measured in kilogram-meters (kg-m.). It is perhaps more usefully regarded as the measure of the ability to resist shock, or "*shock resistance*." As the static tensile test tells whether a test piece is statically strong or weak, so the impact test tells whether it is *resilient* or *irresilient*. Impact-resistance is more accurate than resilience.

Beyond this, the impact test tells us the degree of deformation before rupture under shock. This we may call the "*shock ductility*," corresponding to the elongation and the contraction area of the static test, which we group together as "*ductility*."

<sup>1</sup>J. Ind. Eng. Chem., vol. 8, 1916, 593.

<sup>2</sup>J. Ind. Eng. Chem., 1914, 6, 383.

<sup>3</sup>Met. Chem. Eng., XIV., 247, 1916.

<sup>4</sup>Egloff and Twomey, Met. & Chem. Eng., 14, 247, 1916.



Thus, both file steel and rivet steel are irrisilient, for the file steel offers great resistance to each unit of deformation, it breaks before deforming greatly, and though rivet steel deforms greatly, it offers but little resistance to the unit of deformation because of its low elastic limit.

Turning now to the methods of test, the resilience, or work done in rupture, is determined by subtracting

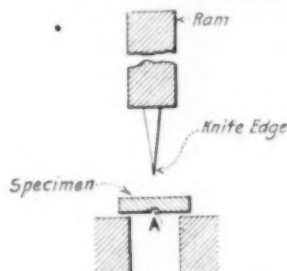


FIG. 1—THE FREMONT NICKED BENDING IMPACT TEST

from the total energy of the blow the residual energy left after breaking the test piece.

Two prominent types of testing machine need attention, those with a vertically falling ram of the Fremont type, Fig. 1, in which the residual energy is measured by a spring against which the ram strikes after breaking the test piece, and those with a swinging pendulum, the impact of which breaks the test piece, Fig. 2. The pendulum then swings on past the fragments of the test piece, and the height to which it now rises is the measure of the energy residual after causing rupture.

Instead of being broken by bending, as in Fig. 1, the test piece may be broken tensilely, by setting its length parallel to the path of the falling ram or tangentially to that of the pendulum.

Finally, the test piece may be either notched or plain, or, as I have suggested lately, threaded through-out its reduced section.

To the Fremont or vertically falling ram type it is objected that the mechanism for measuring the residual energy is untrustworthy, whereas the pendulum type has no corresponding defect, because the height to which the pendulum rises after passing the test piece is not subject to error or to misreading. The objection to the Fremont type is supported by an enormous mass of evidence showing extreme irregularity of results, though in some cases the concordance has been good. Its advocates explain that this represents heterogeneousness of the material tested, an important concession to which I shall return. The validity of this explanation can be tested readily, one believes, by testing the machine in blank, dropping its ram repeatedly from various heights, and noting whether for given height the energy indicated by the dial is constant.

To the bending type of test piece it is objected that this determines primarily the properties of the test piece at one spot only, the outer fiber immediately opposite the point of impact, because the properties of the metal at this spot have a wholly disproportionate influence on the apparent resilience of the piece and on the angle bent. A heterogeneous metal would appear resilient or irrisilient, ductile or brittle, according to whether this part of this outer fiber happened to lie

in a strong or a weak part of the bar, for instance to include or to escape a local flaw.

To nicking a like objection is made, whether for tensile or bending tests, that the properties of the material in the nicked section have a disproportionate influence in determining the resilience and ductility.

This objection applies with double force to the nicked bending test, for whereas in the nicked tensile test the whole of the cross section at the nick resists the stress relatively uniformly, in the nicked bending test it is solely the material at the apex of the nick, A of Fig. 1, that has this disproportionate influence in determining the resistance to rupture. We of course wish to learn the properties of the material at its weakest part. For a piece to be used in tension we wish to know the properties of the weakest section. Hence in our test it is the properties of the weakest section that we seek. Clearly, in a heterogeneous material the chance that the weakest place will happen to lie just at the apex of the nick of a bending test piece is less than that in a nicked tensile piece it will happen to lie somewhere in the nicked section.

Unfortunately, there is much to indicate that the nick is a necessity in testing materials for service in which the object itself is nicked, for instance those in which there is a screw thread. Direct comparative tests tend to show that certain material which has fair resilience when unnicked is very fragile when nicked, and that nicking may reverse the order of fragility of two materials. If this is true, if nicked fragility cannot be inferred from the results of an unnicked test, then I do not see how nicking can be avoided for nicked services.

But there is a special form of nicking which is not open to the objection that it localizes the application of the test, so that it is likely to escape the weaker parts of heterogeneous material, and this is to thread the

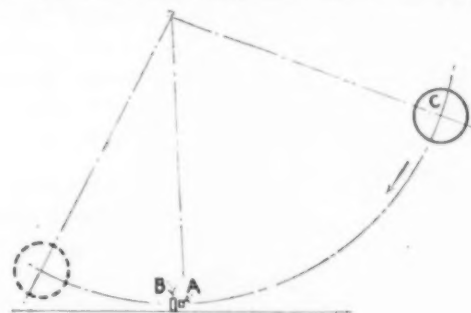


FIG. 2—THE CHARPY PENDULUM FOR IMPACT TESTING.

A—The test piece for the bending test.  
B—The support.  
C—The pendulum.

whole of the reduced section with a sharp spiral thread. With such a thread, rupture should occur at the weakest section in the reduced part of the test piece. The merit of such a suggestion can be learned only by thorough trial.

The nicked bending test is said to be much cheaper to make than any other.

The objection to the bending test and to nicked tests in general—that they are likely to miss flaws, defects, and local weaknesses due to segregation or to foreign bodies or sonims—evidently decreases in force when applied to material known to be extremely homogeneous. For instance, it may prove that the objection should be

waived in the case of crucible steel and of electric steel cast in ingots as small as those usual in the crucible process. Again, it may prove that etching tests may establish the homogeneousness of the material so fully as to justify waiving these objections in view of the cheapness and convenience of the nicked bending test. In that case, material which is shown by etching to be heterogeneous might have to pass a special threaded impact tensile test, while for that shown to be homogeneous the nicked bending test could be used.

Before we can put ourselves in a rational position by adopting a resilience test so as to detect and reject irresilient material for impact services, we need much more light on questions such as those which I have raised, as to the relative merits and the applicability of the several methods of test.

Here two questions seem of extreme importance. First, is there any one form of impact test which will measure the resilience for both nicked and unnicked services, for objects with a screw thread or its equivalent sharp change of section, and for plain objects which lack these changes? On the general principle that the conditions of the test should reproduce the most trying conditions of service, a nicked test is certainly indicated for nicked services. Yet for unnicked service a nicked test seems inappropriate, calling upon the material to possess a quality—ability to resist impact when nicked—which will never be utilized in service and hence is not needed. To provide it is to tax the user and through him the public needlessly. Hence we should learn whether the degree of unnicked resilience can be safely inferred from a nicked impact test. A possible way of answering this question is to apply the nicked test to unnicked objects which, in service, have a relatively small factor of safety and occasionally break; for instance, railroad axles and those parts of motor cars which fail most often. Collect a large number of such objects of which some have failed quickly while others have shown great endurance, and others still have endured only tolerably well. Determine whether a nicked test gives a fair measure of their relative merit.

Conversely, determine how fair a measure of their merit is given by an unnicked test.

Proceeding on the same principle, determine whether a nicked test is really needed for nicked services, or whether the indications of an unnicked test can be trusted. An examination of the existing evidence may well show that for nicked service a nicked test is indispensable. If it does not answer this question fully, then an answer could be had by applying an unnicked test, parallel to that which has just been outlined, to objects some of which, in nicked service, have shown themselves excellent, some bad, and some tolerable.

The second of the important questions concerns the trustworthiness of nicked tests in general. If the investigations already outlined should show that only by a nicked test can fitness for nicked service be determined, then we should have to consider whether the results of test with a single nick are trustworthy, and, if not, whether the test piece should be threaded and tested tensilely. If the great irregularity of the Fremont results, which is certainly very far in excess of the irregularity of static tensile tests on like materials, is traced to defects in his method of measuring the resilience, we should turn to the pendulum machine and determine the concordance of the results to be had with

it, both with nicked bending and with nicked tensile impact test pieces. If neither of these gave concordant results, we should consider the relative merits of the tensile impact test on test pieces threaded instead of being nicked, and of arriving at a trustworthy result by manifolding the single-nick tests, and thus getting a number of results large enough to form trustworthy evidence of fitness, the smallest and not the mean resilience being taken as the true measure.

To perfect and carry out the details of such a program would imply so much work that it might well be undertaken by a commission. To our great consumers, such as the railroads and the makers of motor cars and of electrical machinery, the need of a trustworthy measure of resilience, a trustworthy means of detecting fragility, is so great that they ought to be willing to co-operate in forming such a committee.

The chief questions to be answered may be summed up thus:

1. Can either the nicked or the unnicked test be made to give trustworthy results of fitness for both nicked and unnicked impact service?
2. With materials of such a degree of heterogeneousness as ought reasonably to be provided for, can a single-nicked test piece give a trustworthy measure of resilience?
3. If not, is it more expedient to substitute a two-inch threaded length of impact tensile test piece for the single nick, or to test of each material so large a number of test pieces as to insure detecting approximately the weakest section?

## Zinc Furnace Temperatures—I

### Data on Different Kinds of Ores and Furnaces

By Edward Mackay Johnson

Superintendent Eagle Picher Lead Co.

#### NATURAL GAS FURNACE, COMMON RETORTS

The following temperature data were obtained by the writer on a natural gas furnace with common retorts. They indicate the temperature in the open retort as indicated by Norton cones.

The cones were placed at the back end of the retort, in the middle row, near the middle part of the furnace. The time was recorded when the top of the cone bent over to the clay. The firemen were in no case requested to use the cones as a guide in firing, but merely record the time when the cones went down. It was found, however, that some of the men would take an interest in the cones and even use them as an additional guide in firing. This was especially true of new firemen "breaking in." The cones certainly act as a warning with respect to getting "butchers" as in some cases it was found safe to get No. 7 cone down, with other ores No. 8, and in exceptional cases start No. 9.

Table I represents the average of the daily records, and the writer feels that they are not very far from the temperatures existing in the open retort during the distillation period.

#### REGENERATIVE FURNACE, HYDRAULIC RETORTS

The temperatures in Table No. 2 were obtained with a regenerative type of furnace using hydraulic retorts. As before they indicate the temperature in the open retort as indicated by Norton cones. The cones were placed at the back of the retort in the bottom row

TABLE 1—CONE RECORDS FOR NATURAL GAS FURNACE, COMMON RETORTS

Furnace Number	Month	TIME OF ATTAINING TEMPERATURE OF						
		Cone 03 1090° C.	Cone 01 1130° C.	Cone 2 1170° C.	Cone 4 1210° C.	Cone 6 1250° C.	Cone 7 1270° C.	Cone 8 1290° C.
Part 1. Charge: $\frac{1}{2}$ Leadville Calamine + $\frac{1}{2}$ Western Sulphide								
1	Aug	5:00	7:00	9:00	11:00	1:00	2:30	.....
1	Sept	4:30	6:30	8:30	11:00	12:40	2:00	.....
3	Aug	6:00	8:00	10:00	12:00	.....	.....	.....
3	Sept	6:20	8:30	10:30	12:30	1:00	.....	.....
2	June	5:25	7:15	9:25	11:40	12:25	2:00	.....
2	July	6:30	8:30	10:00	11:30	.....	.....	.....
4	June	5:15	7:20	9:30	11:40	1:35	2:40	.....
4	July	7:20	9:30	10:30	12:00	1:30	3:00	.....
5	July	6:00	8:00	10:30	12:00	.....	.....	.....
5	Aug	5:00	7:30	9:20	11:00	.....	.....	.....
6	June	4:30	6:20	9:15	10:15	12:20	.....	.....
6	July	5:30	7:40	10:00	11:40	.....	.....	.....
6	Sept	5:40	8:30	10:40	12:50	.....	.....	.....
Average time		5:40	7:40	9:45	11:35	1:20	2:25	.....

Part 2. Charge:  $\frac{2}{3}$  Leadville Calamine +  $\frac{1}{3}$  Joplin

2	Oct.	4:00	6:00	8:00	10:00	12:00	.....	.....
4	Oct.	4:30	6:40	9:00	11:00	1:00	2:30	.....
5	Oct.	4:00	7:00	9:30	11:30	12:10	2:10	.....
7	Oct.	3:00	4:40	6:50	9:10	11:40	1:15	.....
Average	time	3:50	6:05	8:20	10:25	12:15	2:00	.....

Part 3. Charge:  $\frac{1}{2}$  Leadville Calamine +  $\frac{2}{3}$  Joplin

7	Aug.	1:00	2:20	4:10	6:20	8:30	10:30	12:20
7	Sept.	2:00	3:40	5:50	8:00	10:00	12:00	.....
9	Aug.	1:00	2:40	4:40	7:00	9:00	10:40	12:30
9	Sept.	1:00	2:30	4:30	6:30	8:30	10:30	12:20
8	June	1:20	3:15	5:30	10:30	12:15	2:30	.....
Average	time	1:24	3:10	5:10	7:55	9:55	11:15	12:20

Part 4. Charge: All Joplin

8	July	1:25	3:00	4:30	7:10	8:30	12:30	.....
9	Oct.	1:00	3:00	5:30	7:30	9:50	10:40	2:15
10	June	1:30	3:20	6:15	9:20	10:25	1:30	2:20
10	July	1:20	3:00	5:30	9:00	10:30	1:10	.....
Average	time	1:20	3:05	5:25	8:15	10:00	12:25	2:17

Analysis of charge:

Leadville Calamine  
Zn... 30%  
Fe... 10  
Mn... 3  
SiO<sub>2</sub>... 12

Western Sulphide  
Zn... 50%  
Fe... 17  
SiO<sub>2</sub>... 2  
Pb... 2.4

Joplin  
Zn... 54.6  
Fe... 4.2  
SiO<sub>2</sub>... 6.1  
Pb... 0.76

TABLE 2—CONE RECORDS FOR REGENERATIVE FURNACE, HYDRAULIC RETORTS

TIME WHEN TEMPERATURE WAS ATTAINED OF									
	Cone 03 1090° C.	Cone 01 1130° C.	Cone 2 1170° C.	Cone 4 1210° C.	Cone 6 1250° C.	Cone 7 1270° C.	Cone 8 1290° C.	Cone 9 1310° C.	
Part 1: Charge of Western Ore; Zn = 53%, Fe = 11%									
	1:07	3:00	5:50	8:15	9:40	11:30	2:30	.....	
	1:08	2:40	4:10	7:15	9:45	12:20	3:00	.....	
Average time	1:08	2:50	5:00	7:45	9:45	11:55	2:45	.....	
Part 2: Charge of Roasted Joplin Ore, Zn = 67%									
	12:15	1:45	3:40	5:35	7:45	10:20	12:50	.....	
	1:00	1:50	3:45	5:50	8:00	10:35	1:40	3:20	
Average time	12:40	1:50	3:45	5:40	7:55	10:30	1:15	3:20	
Part 3: Charge of Silicate Ore, Low in Pb and Fe									
Average time	1:10	2:30	4:15	5:50	7:25	8:40	10:30	12:50	

All times represent the average reading for two months.

about the middle of the furnace. The time was noted when the cone had bent over to touch the clay.

From a comparison of Tables 1 and 2 it will be observed that there is considerable difference between them with respect to the Western ores, while upon the Joplin ore they agree more closely. This is mainly due to the fact that some metallurgists when treating Western ores bring the furnace along somewhat faster and work it off closer, while others bring the furnace up slowly, holding it a little greener in the morning, and thereby obtaining more metal at the third draw. If the recovery be the same in both cases the latter method is to be preferred, as it is easier on the retorts, the men, and the furnace.

## COAL-FIELD FURNACE, HEGELER TYPE

The following is a log of furnace temperatures taken between the retorts in the laboratory of a coal-field furnace of the Hegeler type, with no regenerators;  $1\frac{1}{4}$ -in. slack coal was used, and the furnace operated on Joplin ore. Charging of the furnace was commenced at 5 a. m. and finished at 11 a. m. The draft in the furnace was from 2 in. to  $2\frac{3}{4}$  in.; in the producer it varied from  $\frac{1}{2}$  in. just after coaling to 4 in. just before recoaling.

TABLE 3—PYROMETER READINGS IN DEGREES C. IN HEGELER FURNACE

4th Sec., 3d Row		14th Sec., 3d Row		19th Sec., 3d Row		Remarks
Time	Temp.	Time	Temp.	Time	Temp.	
A.M.		A.M.		A.M.		
10:55	1060	10:58	900	11:00	815	Clinkered. Air pressure off 8 min.
11:28	1070	11:32	920	11:35	860	
11:55	1085	11:58	970	12:10	890	
P.M.		P.M.		P.M.		
1:03	1130	1:15	1085	1:18	1015	Clinkered. Air pressure off 7 min.
1:52	1140	1:58	1110	2:00	1040	Coaled up. Air pressure off 4 min.
2:46	1155	2:55	1125	2:58	1075	Clinkered. Air pressure off 7 min.
3:42	1165	3:47	1150	3:51	1090	Coaled up. Air pressure off 5 min.
4:58	1165	5:50	1160	5:09	1115	Clinkered. Air pressure off 8 min.
5:55	1210	5:59	1180	6:04	1110	Coaled up. Air pressure off 3 min.
6:55	1220	7:01	1210	7:06	1120	Clinkered. Air pressure off 9 min.
				7:09	1030	
				7:15	1080	
7:58	1200	8:05	1220			Coaling up. Air pressure off 5 min.
8:53	1230	8:59	1200	9:03	1140	
9:22	1230	9:26	1215	9:30	1165	Clinkering. Air pressure off 15 min.
				9:31	1155	During this clinkering and coaling up, the temp. dropped 60 in the blue powder.
				9:32	1130	
				9:33	1125	
				9:35	1110	
				9:42	1105	
				9:48	1140	
10:21	1240	10:26	1220	10:30	1165	
11:11	1265	11:16	1230	11:18	1190	Clinkering. Air pressure off 9 min.
						Temp. in blue powder dropped 55 deg.
				11:19	1170	
				11:20	1155	
				11:23	1140	
				11:25	1140	
				11:27	1135	
A.M.		A.M.		A.M.		
12:19	1265	12:25	1230	12:27	1190	
12:59	1275					Clinkered. Air pressure off 9 min. Temp. in the fronts dropped 20 deg.
1:00	1270					
1:01	1265					
1:03	1255					
1:04	1250	1:10	1230	1:14	1195	Coaling up. Air pressure off 5 min.
2:03	1275	2:45	1250			
		2:46	1250			Clinkering. Air pressure off 10 min.
		2:44	1245			
		2:50	1240			Middles dropped 20 deg.
		2:53	1235			
		2:55	1230	3:00	1225	
3:50	1270					Coaling up. Air pressure off 3 min.
3:52	1255	3:59	1255	4:01	1215	
4:40	1275	4:50	1255	4:55	1195	
		5:48	1250	5:50	1240	Clinkering. Air pressure off 8 min.
Lowest	1060		900		815	
Highest	1275		1255		1225	Total time pressure off: 1 hour.

## COAL-FIELD FURNACE, REGENERATING TYPE

In the following table are listed pyrometer temperatures in degrees C. in the laboratory of the furnace on both sides of the block:



TABLE 4—PYROMETER READINGS IN DEGREES C. IN COAL-FIELD FURNACE

	Time	Row No.			Average
		1	2	5	
Section 2.....	3:50 P.M.	1300	1220	1185	1201
Section 8.....	3:50 P.M.	1220	1230	1175	1208
Section 18.....	3:50 P.M.	1220	1230	1170	1207
Average.....		1213	1227	1177	1205
Opposite side:					
Section 2.....	4:10 P.M.	1230	1235	1120	1195
Section 8.....	4:10 P.M.	1220	1250	1170	1213
Section 18.....	4:10 P.M.	1230	1230	1165	1208
Average.....		1227	1238	1152	1205
General average.....		1220	1232	1165	1205

## CONCLUSIONS

There is too much variation in the volume of gas just before and after coaling up when using  $1\frac{1}{4}$ -in. screenings in a Hegeler producer for a non-regenerating type of furnace, due to the rapid combustion of such fine coal. This necessitates more frequent coaling up, and a consequent slight cooling of furnace. The fine coal with no steam blown into the producer forms large lumps of clinker, thus prolonging the clinkering time unduly. By coaling up once an hour there was a sufficient volume of gas of very good quality, and as seen from the temperature record in Tables 3 or 5 the furnace picked up very well during the first stage of the operation. It was, however, very difficult at the latter part of the process to force the backs (i.e., from the 10th to 15th section) without retarding and even cooling off the fronts. The troubles were also aggravated by the increased charging time due to the great amount of producer ash carried into the furnace laboratory, thereby forming an unusual amount of glaze in the furnace bottoms and upon the back lining and retorts. Under these conditions there is hardly any question but that the four-row furnace would at least give the best recovery.

TABLE 5—RECAPITULATION AND DEDUCTIONS FROM TABLES 1 TO 4; JOPLIN ORE

Reference	Location	TIME WHEN TEMPERATURE WAS ATTAINED OF										CHARGING	
		Cone 03 1090° C.	Cone 01 1130° C.	Cone 2 1170° C.	Cone 4 1210° C.	Cone 6 1250° C.	Cone 7 1270° C.	Cone 8 1290° C.	Cone 9 1310° C.	Start A.M.	End A.M.		
Table 1, part 4	Open retort.	1:20	2:57	5:10	7:55	9:48	12:00	1:10	...	4	9		
Table 2, part 2	Open retort.	12:40	1:50	3:45	5:40	7:55	10:30	1:15	3:20	5	11		
Table 3, column 1	Laboratory*	11:55	1:03	5:00	8:00	10:20	12:20	5:00	...	5	10		
Table 4	Laboratory†	11:00	12:00	2:00	4:00	6:00	8:00	10:00	12:00	5	10		

\*The approximate time noted on this line was taken from the first column of Table 3, and therefore corresponds to the 4th section only.

†Interpolated from the temperature at four o'clock which was 1205° C. according to Table 4.

An examination of Table 5 seems to show it in error that it indicates temperatures in the laboratory at a later time than the same temperature in the retort. This seems unreasonable, inasmuch as the heating atmosphere must attain a certain heat before the heated body. These comparisons of temperatures, however, are made on furnaces of different type, and merely confirm the actual facts that the furnace in question did not pick up in heat fast enough, and the blue powder could not be worked close enough. Consequently the recovery was unsatisfactory.

Opposite is an analysis of clinker, glaze and slag:

## The Gambler

Safety Bulletin, Illinois Steel Co.

A gambler is a man who stakes something of value on an uncertainty. It matters not what that something is. It may be money, health, happiness or life itself, but if he pits it against chance, if he wagers it on a fortuitous turn of life's wheels—he is a gambler, pure and simple. There are many men who would consider themselves defiled if they even so much as fingered a playing card, or looked with sympathetic eye upon a game of chance, who daily jeopardize their lives with unnecessary risk of accident, or injure their health in useless exposure.

It is right enough to have our scruples in connection with those things which the world deems bad, but let us be consistent; let's come clean on this business of taking a chance.

The chance taker is a peculiar menace in the railroad ranks. If, through thoughtlessness, he injures or kills himself, there is untold suffering to those who love him, his own hopes and ambitions stop short of fulfillment and a producer has been removed from his proper place in the general scheme of things.

If, through negligence, of failing to think, the chance taker causes the injury or death of a fellow employee, there must be added to all of the other suffering, a consciousness of his own failure to abide by the simple principles of safety and caution.

It matters not how straight laced a man may think he is, there is something wrong with his morals when he does not feel and constantly endeavor to live safely and sanely, with due regard to his own life and the lives of those about him.

God gives every man the right to live, and if he trifles with that right or with the same right possessed by his neighbor, he is a dangerous gambler and not cognizant of his moral responsibilities.

It's a great mistake to think there is no religion in the rule book. The rule book was not published by a church, but a railroad man cannot be a good churchman, unless he tries to live up to the rule book.

Let's cut out gambling in human life, and try to live straight!

The Research Corporation, incorporated in 1912 by Dr. F. G. Cottrell to administer his patents on electrical precipitation of suspended particles, has decided to offer a fellowship of the annual value of \$2,500 for the purpose of encouraging scientific research in the development of the industrial arts. The fellowship will be awarded after competition consisting of the submission of evidence of scientific attainments, discoveries or inventions and of special fitness for advanced work. The competition will be decided on Dec. 1, 1917, and the successful candidate will be required to begin his research or investigation immediately. Each fellow is required to present a written report of the results of his work to the corporation at the conclusion of his appointment, but any discovery or invention which he may make shall be deemed his personal property.

	SiO <sub>2</sub>	FeO	CaO	Al <sub>2</sub> O <sub>3</sub>
Producer clinker.....	45.5%	15.9%	11.5%	24.3%
Retort glaze.....	61.6	13.7	4.7	20.3
Furnace bottom slag.....	53.9	9.5	5.4	27.1

# Some Notes on Nitrating Kettles with an Example of Acetylation Apparatus

By Frederick Pope

Nitration is ordinarily carried out in metal vessels, sometimes cooled and sometimes heated. For many purposes, however, it is advisable or even necessary that nitration be conducted in vessels of earthenware,

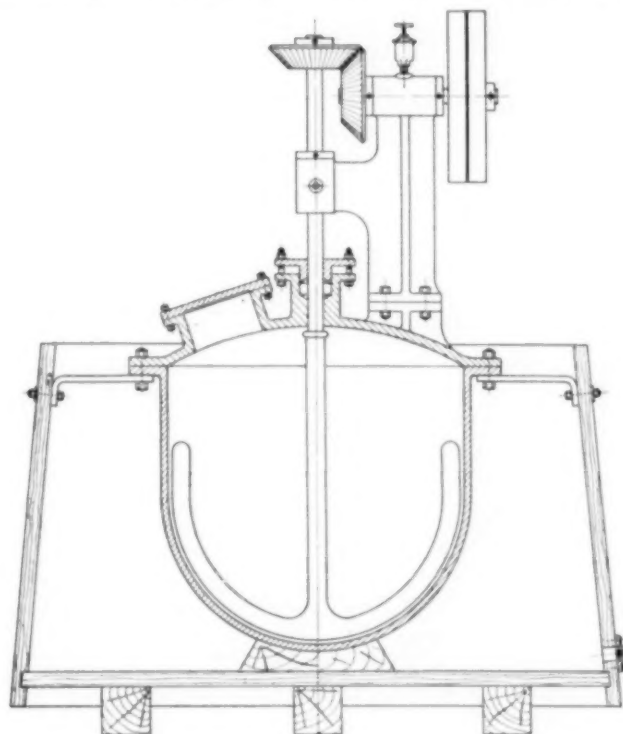


FIG. 1—SIMPLE FORM OF NITRATING KETTLE

glass, enameled or special acid resisting metal such as corrosiron, duriron, tantiron, etc.

The nitrating agent is ordinarily nitric acid, mixed nitric and sulfuric acid, or one of the alkali nitrates, sodium nitrate, for example.

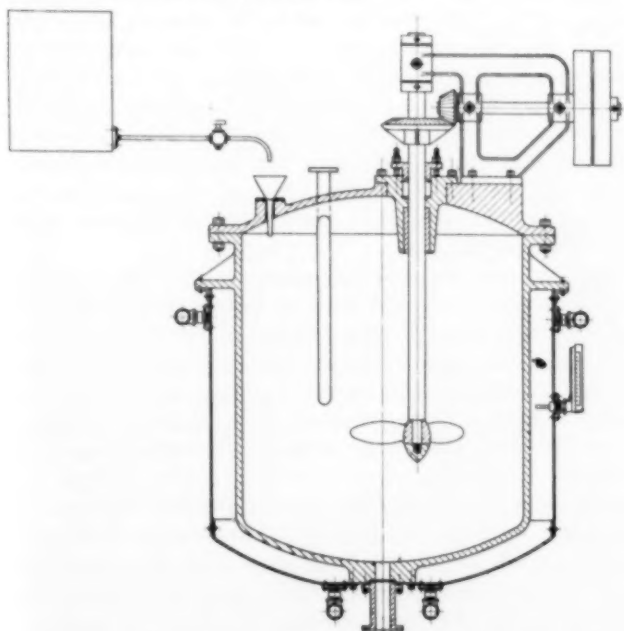
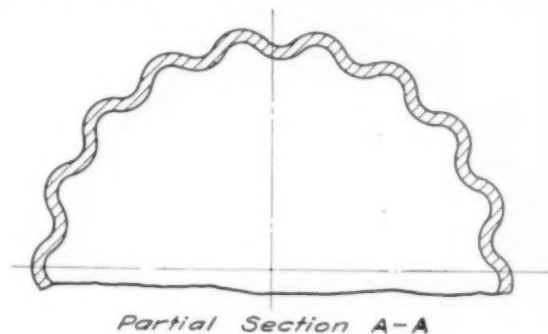


FIG. 2—ORDINARY SMALL NITRATING KETTLE

Fig. 1 shows what is perhaps the simplest form of nitrating kettle, one seldom found in the United States, although not uncommon in Europe. It is a simple cast-iron kettle provided with a mechanical stirring device, set in a wooden tub so arranged that the kettle may be surrounded with either water or ice water. This kettle is discharged either by blowing or with a siphon.

Fig. 2 shows an example of an ordinary small nitrating kettle, arranged for cooling or gentle heating, hot water or low-pressure steam being used in case heating



Partial Section A-A

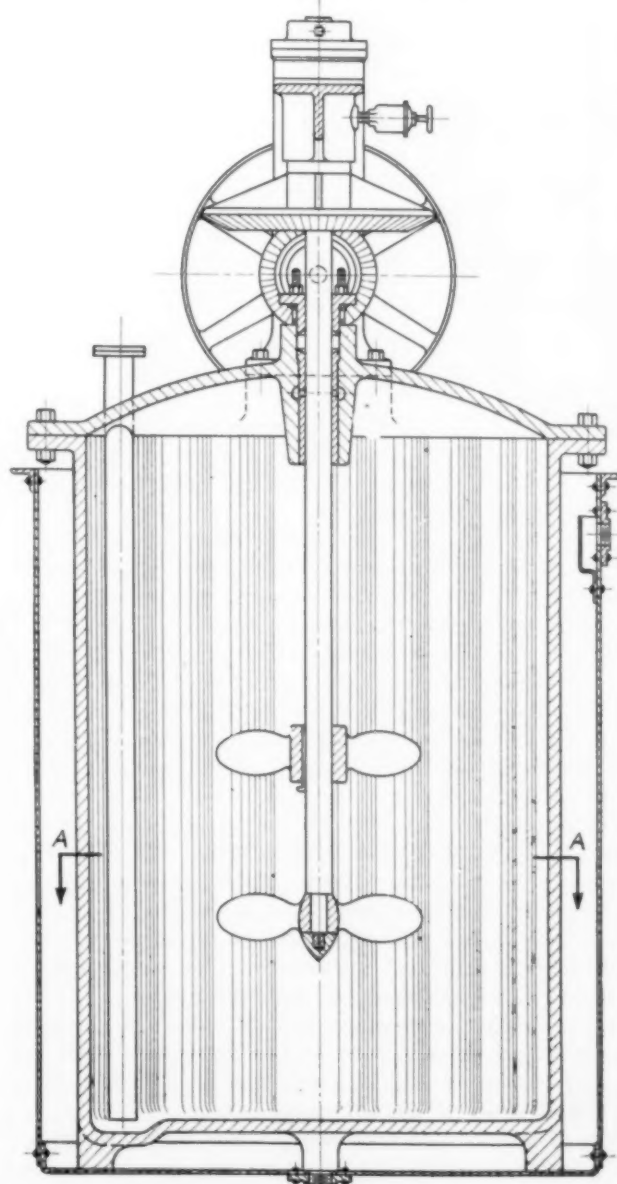


FIG. 3—NITRATING KETTLE WITH CORRUGATED SIDES

*Note: Driving Mechanism Omitted*

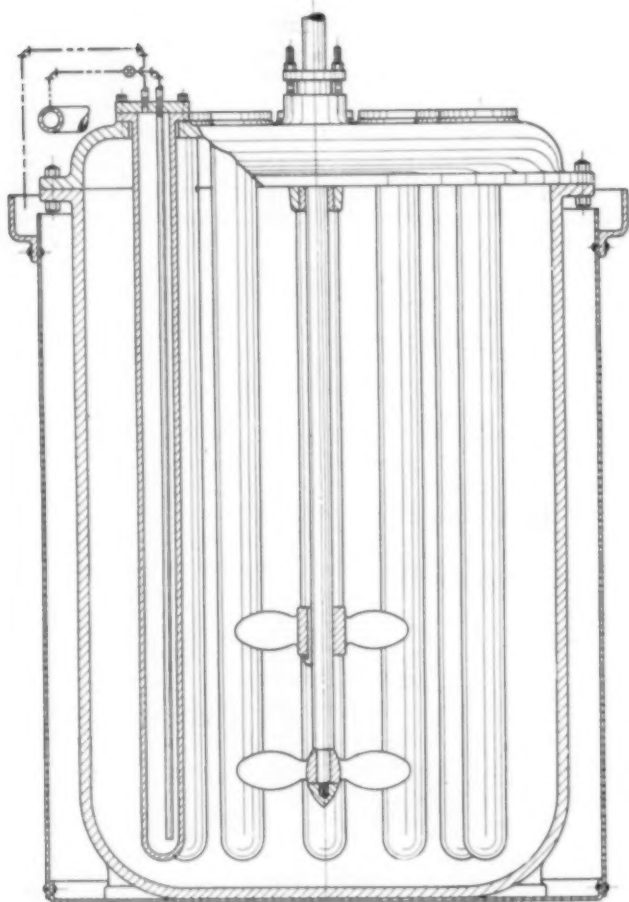


FIG. 4—DESIGN FOR LARGE KETTLES

is desirable. For either brine or water there must be a number of inlets at the top and a number of outlets at the bottom, arranged so that the water or brine in circulation will not channel.

In many instances the rate at which nitration can be carried on is determined by the amount of cooling possible. To promote rapid cooling, a number of expedients have been resorted to.

Fig. 3 shows a nitrating kettle, the sides of which are corrugated so as to present a greater surface for cooling than an ordinary round kettle. This is a somewhat difficult casting to make, and is a type which has not met with very great favor in this country.

Another method is to provide closed-end tubes extending into the liquid in the kettle from the top, as well as a jacket surrounding the kettle. This is illustrated in Fig. 4. By this means the cooling surface is increased very considerably, and this design is used extensively in large kettles. Nitrating kettles of this sort, with a capacity from twelve to fifteen hundred gallons, are largely used for nitrating benzol.

When neither low temperature nor a rapid abstraction of heat is necessary, the cooling is accomplished by cooling water. A kettle equipped with a jacket, such as shown in Fig. 2, is often used.

Fig. 5 shows an earthenware apparatus for nitration. This is set in a vessel so that it may be surrounded with cracked ice or ice water. A tub similar to that shown in Fig. 1 is often used.

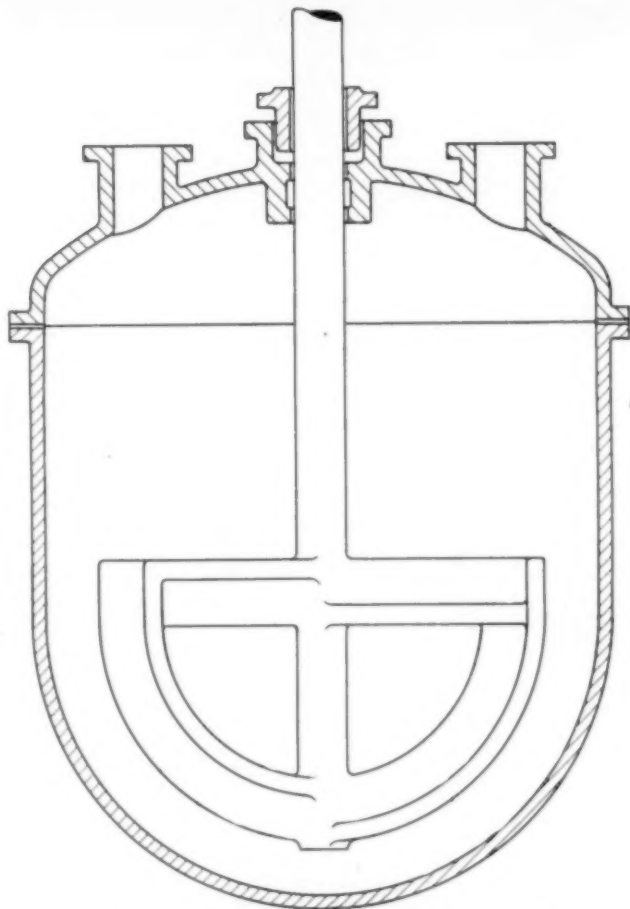


FIG. 5—EARTHENWARE NITRATION APPARATUS

For some nitrations where heating to comparatively high temperatures is necessary we use an apparatus such as shown in Fig. 6. Here the heating is accomplished by steam of a sufficiently high pressure to give the desired temperature or steam superheated to give the desired temperature.

Mononitration and dinitration of a variety of substances are successfully carried out in continuous apparatus. Fig. 7 shows one form of nitrator used for continuous nitration, which has been very successfully used, particularly in the manufacture of nitrobenzol. The cooling here is accomplished by the circulation of water through the coils marked *d*, as shown in the drawing; *a* and *b* are inlets for benzol and acid respectively; *c* is the outlet for nitrobenzol. Accurate results are possible in this apparatus, which is very nearly automatic.

Fig. 8 shows complete apparatus for continuous nitration. Benzol from the tank *b* enters the column *a* through the tube 1. The mixed sulfuric and nitric acid from the tank *c* enters the column through the tube 2. The spent acid leaves the column by the pipe 3, and is collected in the tank *d*. The crude nitrobenzol as produced in the column *a* leaves through the pipe 4 through the watch glass *e*, entering the washer *f*. The wash water enters the washer through the pipe 5 and leaves through the pipe 6. The washed nitrobenzol leaves the washer through the pipe 7, passing through *g*, where it is heated, enters the column *h*, through the pipe 8, which acts as a refining column. The purified nitrobenzol leaves the column by the pipe 9, passing into the cooler *i*. It leaves the cooler through the watch



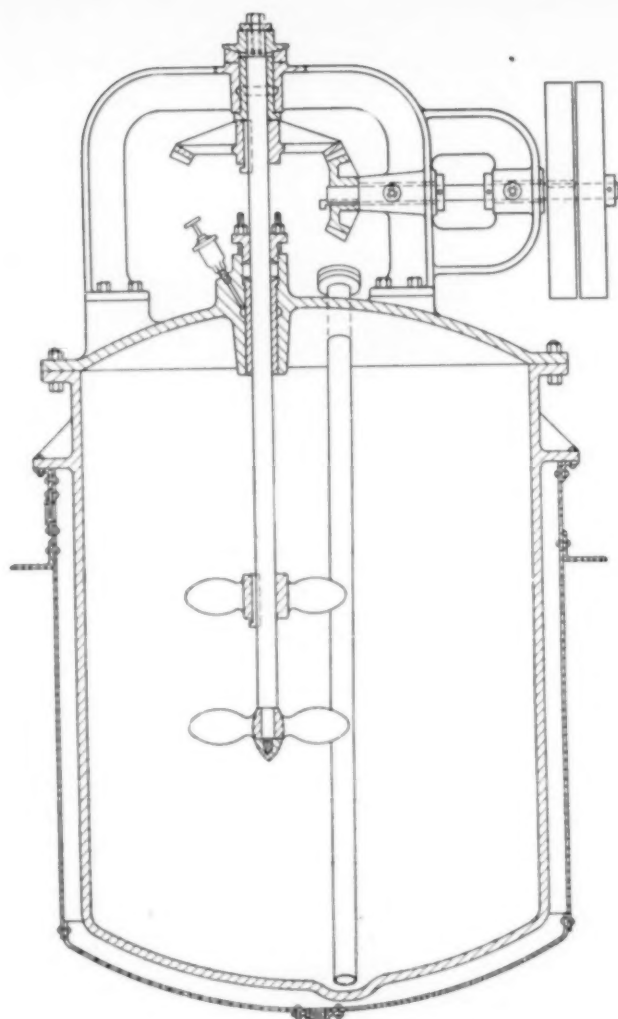


FIG. 6—APPARATUS FOR HIGH TEMPERATURES

glass *j*, enters the separator *k*, where the pure nitrobenzol passes off through the pipe 10 and the water through the pipe 11. The excess of benzol which has been distilled from the nitrobenzol leaves the column *h* through the pipe 12, passes through the partial condenser *g*, enters the cooler *l*, passes through the watch glass *m* and into the separator *n*. The benzol from the pipe 13 is returned to the tank *b*, while the water passes off through the pipe 14. Steam is admitted into the column *h* through the pipe 15. Cooling water for the nitrating column enters through the pipe 16 and leaves through the pipes 17.

A nitrating kettle must always be provided with a cover, usually of the same material of which the kettle is constructed. The joint between the kettle and the cover is usually made with asbestos, rubber or other material, the nature of the joint being determined by the material treated, the material of which the kettle is made, and the pressure to be carried within the kettle. For some materials, asbestos and silicate of soda is very successful.

A variety of agitators are used in nitrating kettles. The off-center propeller, such as shown in Fig 2, is for many purposes the most advantageous. For a large class of nitrations the simple gate type of agitator, such as shown in Fig. 5 for an earthenware kettle, is entirely adequate. Two off-center propellers on the same shaft, the propellers throwing in opposite directions,

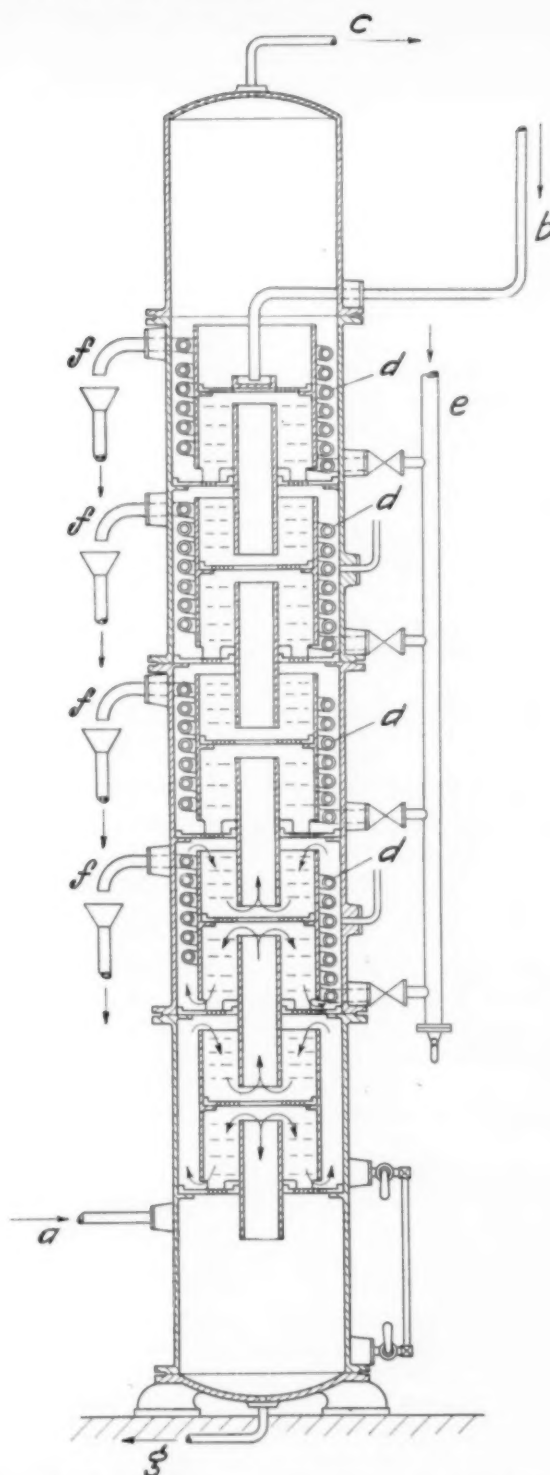


FIG. 7—CONTINUOUS NITRATION APPARATUS

as in Fig. 6, are especially good for large kettles.

When the propeller type of agitator is used, care must be taken that the propeller suits the condition. There is one correct speed for a propeller, which depends upon the size and shape of the kettle, size, form and pitch of the propeller, and the consistency of the liquid in the kettle. With all these conditions determined, there is one correct speed of the propeller. If this is considerably departed from, its efficiency as an agitating device is materially decreased. It follows then that if the consistency of the liquid in the nitrating kettle changes considerably in the course of nitration the propeller type of agitator is unsuitable.

Fig. 9 shows a stirring device which is used when solids such as alkali nitrates are used in nitration. In some cases it is necessary to go beyond the precautions taken here, and the lower blade of the stirring device is made in the form of a rake.

Fig. 10 shows a complete nitrating arrangement where brine cooling is necessary. This would illustrate, for instance, an installation for the nitration of acetanilid, making paranitracetanilid; *a* is nitrating kettle, *b* is an acid reservoir, *c* a brine tank, *d* a brine pump, *e* an ammonia compressor, *f* an ammonia condenser, *g* an ammonia receiver, *h* ammonia expansion and cooling coils, and *i* a reservoir.

The system is too well known to require more than the barest description. Ammonia is compressed and then passed through an ammonia condenser, where it is cooled and then allowed to expand, passing through pipes in the brine tank, and cooling the brine, returning again to the compressor. Cold brine is pumped to the jacket of the kettle, where it abstracts the heat from the reaction, and is then returned to the brine tank. Needless to say one brine tank can be used for a number of nitrating kettles.

In some plants, where exhaust steam and plenty of cooling water is available, the absorption type of refrigerating machine is often advantageously employed.

#### An Example of Acetylation Apparatus

Acetylation may be carried on in aluminium, silver or silver-lined apparatus. Fig. 11 shows a typical example of an acetylation apparatus which is especially designed for the acetylation of aniline oil in the manufacture of acetanilid. The kettle itself is made of sheet aluminium, with all the joints welded. Surrounding the kettle is an iron jacket, which is set in a furnace fired preferably by gas, but conveniently by either oil or coal, the iron jacket forming an air bath for the kettle. These kettles are also heated by circulating oil, as sulfonating kettles are sometimes heated, but on

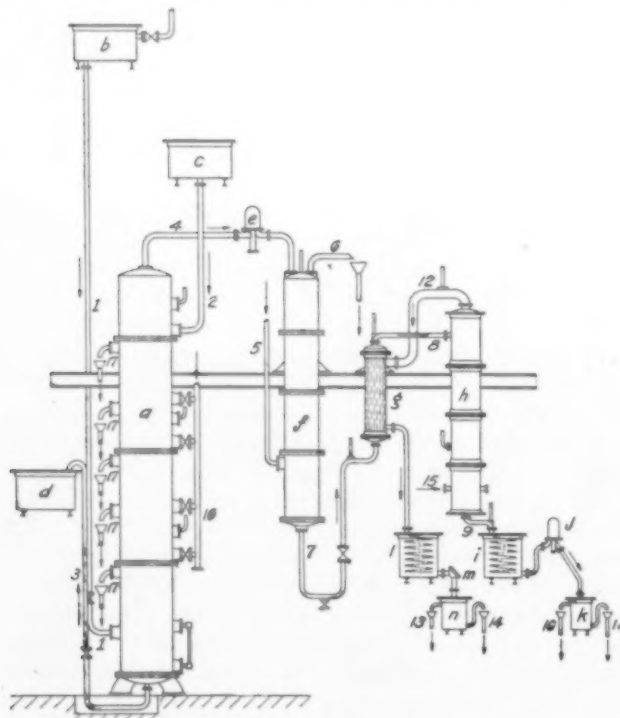


FIG. 8—COMPLETE CONTINUOUS NITRATION APPARATUS

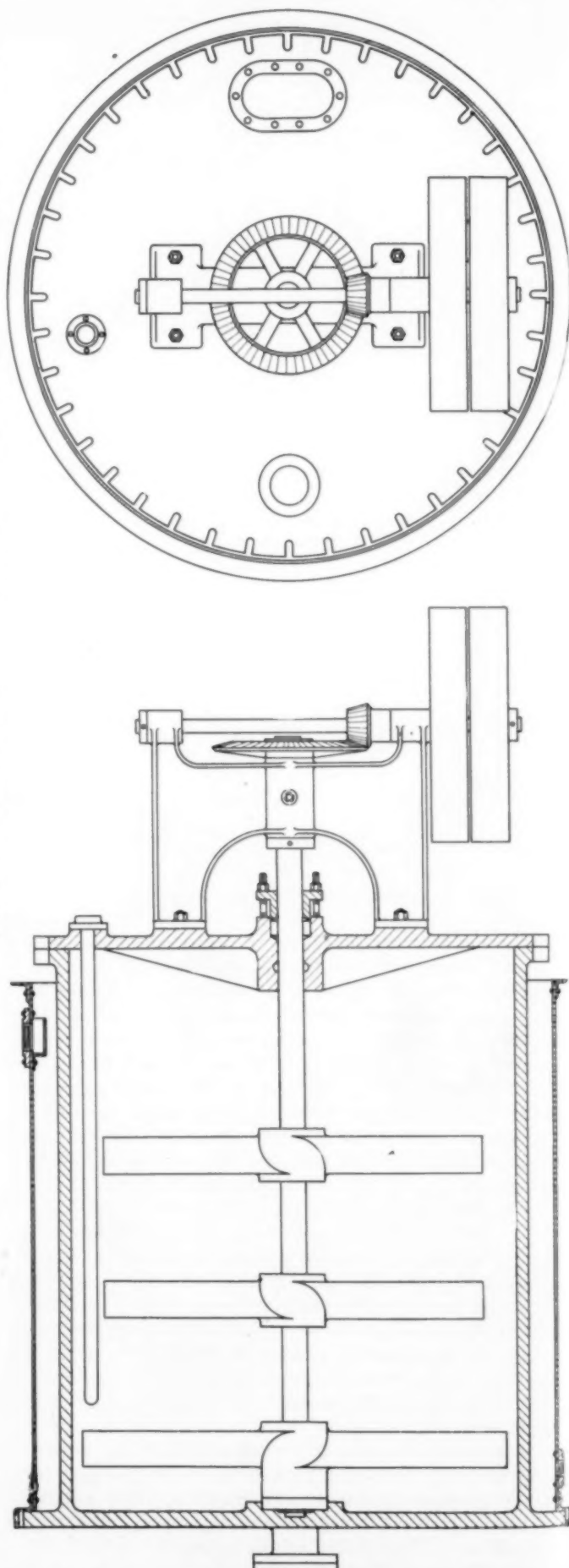


FIG. 9—STIRRING DEVICE FOR USING SOLID NITRATES

account of the high temperature necessary at the end of the operation, the oil circulating method of heating is sometimes troublesome. When heating is accomplished by circulating oil, bottom discharge may be used, but it is fully as convenient to discharge the kettle by means of air pressure through a pipe extending to the bottom, as shown in the drawing.

The kettle is equipped with reflux condenser. This may be the boiling head type, as shown, or it may be a column with Raschig rings, one filled with glass marbles, or simply baffle plates. The use of a boiling deck or a Raschig ring column permits the use of a weaker acid for acetylation.

Connecting to this column is a silver tube

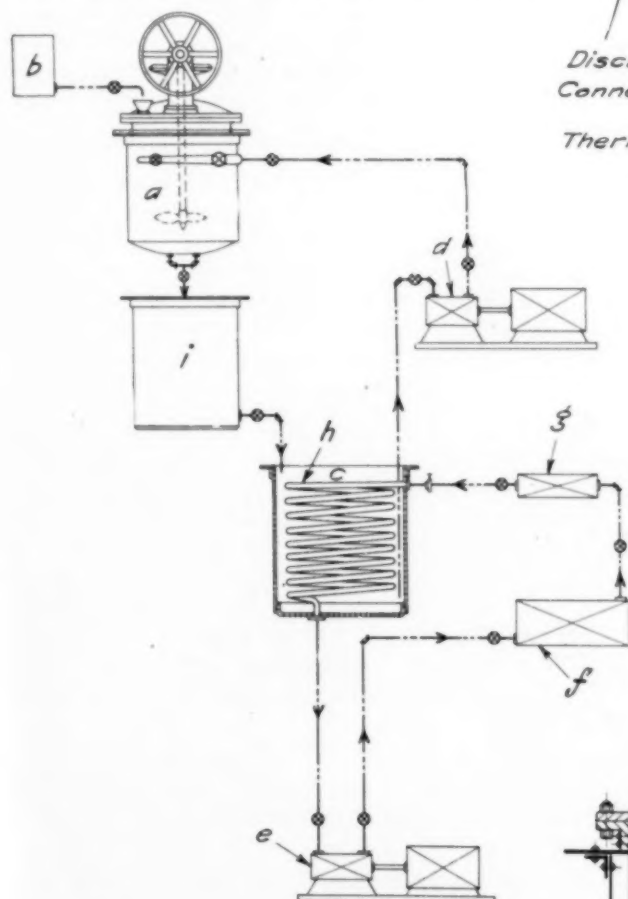


FIG. 10—ARRANGEMENT FOR BRINE COOLING

condenser so arranged that it may be used as a reflux to return the condensate to the kettle, or as a condenser discharging into a receiver. This is managed by the valves marked *a* and *b*. The valves may be earthenware cocks, silver cocks, or a gate valve, very heavily silver-plated. In practice, it is an excellent precaution, in case a silver-plated gate valve is used, to have the plating done twice. A watch glass, marked *c*, is provided at the end of the condenser, so that the operation of the apparatus shall be evident to the operator. The kettle is provided with a silver thermometer tube extending well to the bottom. A recording thermometer should be provided.

The cover, which is bolted securely to the kettle and made tight with an asbestos or silver gasket,

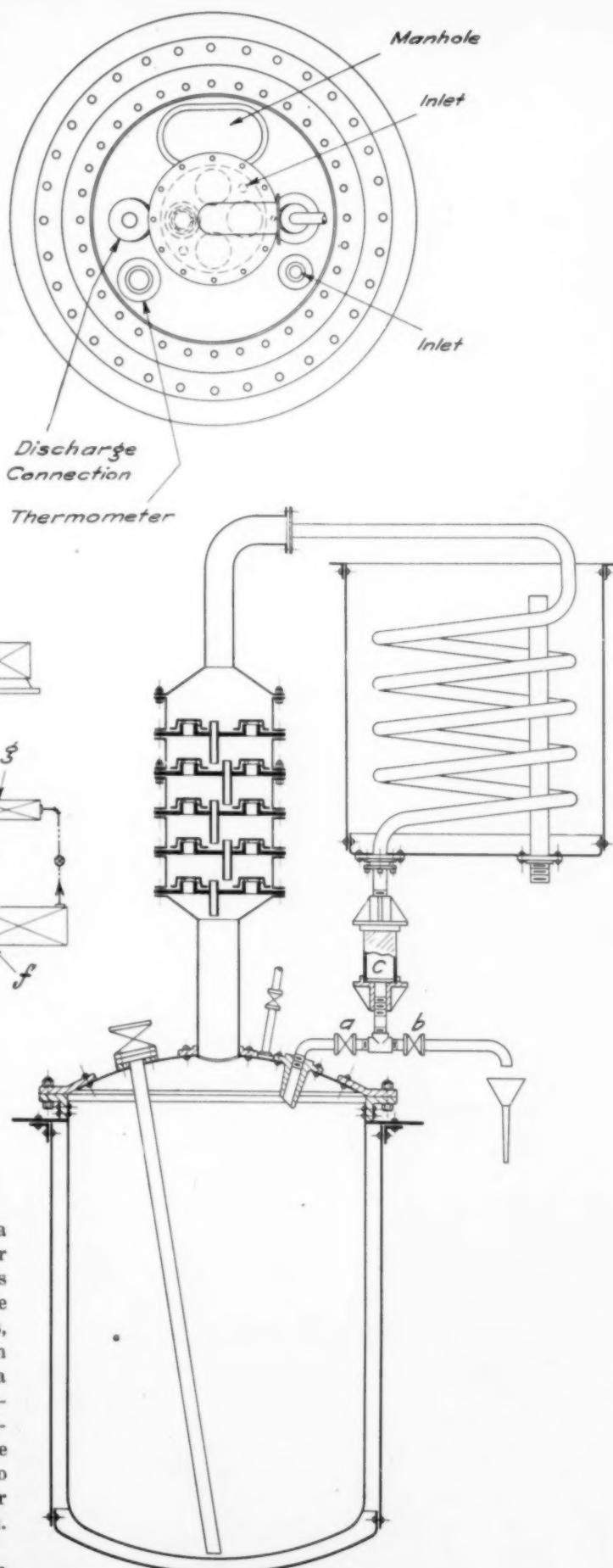


FIG. 11—ACETYLATION APPARATUS



is provided with a manhole, an opening for acetic acid, a separate opening for anilin oil, a separate opening for introducing air to discharge the kettle, an opening for the returns from the condenser, and an opening connecting with the discharge pipe extending to the bottom of the kettle. All these openings must be provided with either silver cocks or silver-plated gate valves.

A very pure sheet aluminium must be used for the kettle, and the joints must be carefully welded. Aluminium solder is entirely inadmissible in any part of the apparatus. The cover is made of sheet aluminium, riveted to a cast aluminium ring, which is in turn bolted to a cast aluminium ring, which is riveted to the kettle.

The boiling head may be made of sheet aluminium. In case boiling decks are used, the decks may be cast aluminium. In case Raschig rings are used, they may be of earthenware, aluminium or silver, and may be contained in a sheet aluminium boiling head. Satisfactory results are obtained from an apparatus such as described when used for the manufacture of acetanilid.

### Oxide of Zinc\*

By George C. Stone.

The method of making oxide of zinc direct from the ore was invented and developed at the works of The New Jersey Zinc Co. at Newark in the middle of the last century. The process was invented by Burrows, who had not the ability, financial or technical, to work out the details necessary to make it of commercial value. This was done by Colonel Wetherill, whose name is commonly attached to this process. The grate bars used are also frequently called Wetherill grates, which is a misnomer because they were in common use for boiler firing at the time and he never claimed their invention.

The invention of the process was due to the efforts of The New Jersey Zinc Co. to find a profitable means of working the ores from Franklin and Sterling Hill, N. J. These are a mixture of franklinite, willemite and zincite, containing about 20 per cent of zinc. The first attempts were to make spelter, which were not successful, owing to the low grade of the ore and the fusibility of the residue. Failing in this, the next attempt was to make oxide in large muffles and reverberatory furnaces. This succeeded, although the cost of operation was high, the recovery low, and the quality of the product uncertain. In 1855, the new process was patented and has been in successful operation ever since its introduction.

Essentially, the process is to spread a mixture of coal and ore on a body of burning coal on a perforated grate and blow an excess of air through the grate. The zinc is reduced in contact with the coal, volatilized and burned by the excess of air in the upper part of the furnace and in the flues. It is then carried to the bag rooms by the excess air and products of combustion which are forced through the flues by fans. In its main features, the process is the same to-day as at the time of its invention, but the details have been so modified that it would hardly be recognized by its originators.

\*A paper to be presented at the St. Louis meeting of the American Institute of Mining Engineers, October, 1917.

### ORES

The process is applicable to all the oxidized ores of zinc and to roasted sulphides, provided the gangue is not so fusible as to leave a residue that is impervious to the blast. In many cases the ores contain impurities that make it impossible to produce an oxide of a good enough color to be available as a pigment. These impurities are any volatile metals that form colored oxides or sulphides. Cadmium is one of the worst, because it is very volatile and its dark brown oxide and bright yellow sulphide both have strong tinctorial powers, so that small fractions of a per cent seriously injure the color of the oxide. Lead, which is one of the commonest impurities in zinc ores, also injures the color, though to a much less degree, as it usually forms basic sulphates which are nearly white. On other accounts lead is often objectionable, particularly when the oxide is to be used for the manufacture of rubber goods. Sulphur may occur in oxide as sulphides, sulphates or as sulphurous anhydrides, the first and last of which are objectionable; the first on account of probable injury to the color, while the last is believed by many paint manufacturers to have a bad effect on the grinding properties. Opinion on the latter point is by no means unanimous. Sulphates, if soluble, have very objectionable qualities for outside paints, as they leach out of the paint-coat, leaving discolored spots. Chlorides, in appreciable quantity, are rare, but if present would be open to the same objection.

### FUEL

The fuel used must be one that does not give a black smoke, which would ruin the color of the oxide. Anthracite is the most satisfactory fuel for the purpose and the one generally used. In the West, where anthracite is expensive, semi-bituminous coals, low in volatile qualities, are sometimes substituted for it in whole or in part, but they are never as good. Coke alone does not work well, as it causes a very intense local heat that makes the residue impervious to the blast. It is occasionally used as a part of the charge fuel.

### FLUXES

With siliceous ores, limestone is sometimes added, but in general it does more harm than good, owing to its tendency to make the residue too fusible.

### PREPARATION OF CHARGE

The ores and coal are usually received at the works in fine enough condition for use without further crushing. Nearly all the ores are either concentrates or roasted products and are inevitably finer than is necessary. As the small sizes of coal are suitable for the purpose, and are cheaper than the large, they are invariably used. If fluxes are used they are crushed to about the size of the ore and coal. There should not be a great difference in the size of the different materials, or it will be impossible to mix them properly.

### PALMERTON PLANTS

The Palmerton plants of The New Jersey Zinc Co. (of Pennsylvania) are the largest and best equipped oxide plants in the world.

Fig. 1 shows the general arrangement of the West plant and Fig. 2 that of the East. They are similar, but the East plant has fewer and larger bag rooms and

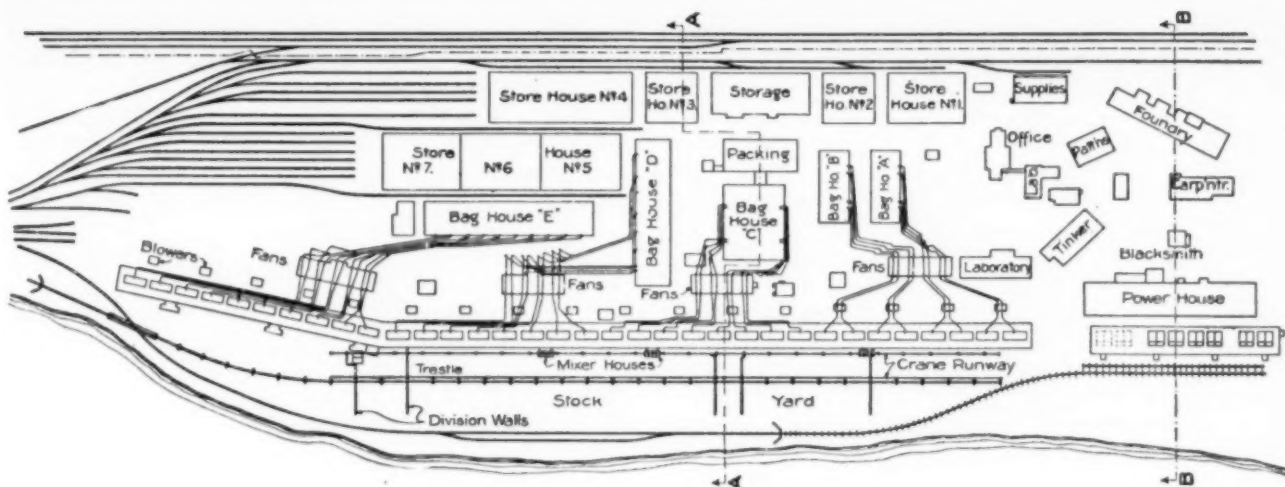


FIG. 1—PLAN OF WEST PLANT

differs somewhat in details. At both plants the raw materials are delivered on the trestle at the south of the plant and are either placed in bins or stocked in piles. The ore and coal are taken from the bins to the mix-house by larries. The mixed charges are delivered to the bins above the furnaces and distributed by traveling cranes. Each block of furnaces is a separate unit, having its own blower, exhaust fan and bag room. The oxide is trucked from the bag rooms to the packing room and the final packages skidded or trucked to the storehouses.

#### STOCKING AND MIXING—EAST PLANT

The ore and coal are delivered on the double track, steel and concrete trestle, 22 ft. high with Brown tangential bins below the track next to the furnace room. Materials for current use are dumped directly into the bins and the surplus is stocked back of the trestle by a bridge crane of 233 ft. 9 in. span equipped with a 10-ton Brown grab-bucket. This equipment also returns materials from the stock piles to the bins when necessary. The charges are drawn from the bins to a weighing larry which has two hoppers, each containing a furnace charge. These are carried to Ransome concrete mixers placed at one end of the furnace room.

The mixed charges are elevated by a pair of counter-balanced skips to bins above the furnaces. From the bins the mixed charge is taken to the furnaces by cranes each having three hoppers holding one-third of a furnace charge each. Each hopper is placed on a scale so that the charge is equally divided between the three.

#### STOCKING AND MIXING—WEST PLANT

All materials are delivered on a single track steel and concrete trestle 47 ft. high, down the center of the storage yard. The materials are taken from this by a bridge crane of 48 ft. 8½ in. span with a 2-yd. bucket and placed in elevated bins next the furnace room. The ore and coal are stocked and reclaimed by the traveling bridge and by locomotive cranes on the high trestle. The total storage capacity is 200,000 tons of ore and 175,000 tons of coal. The fuel and the various ores are taken by bridge cranes to small bins placed over the mixers. The materials are dropped from these bins into weighing hoppers and from these into the Ransome mixers. The mixed charges are elevated to bins over the furnaces and then distributed by cranes much as at the East plant, except that there are no scales on the cranes or larries. This arrangement of

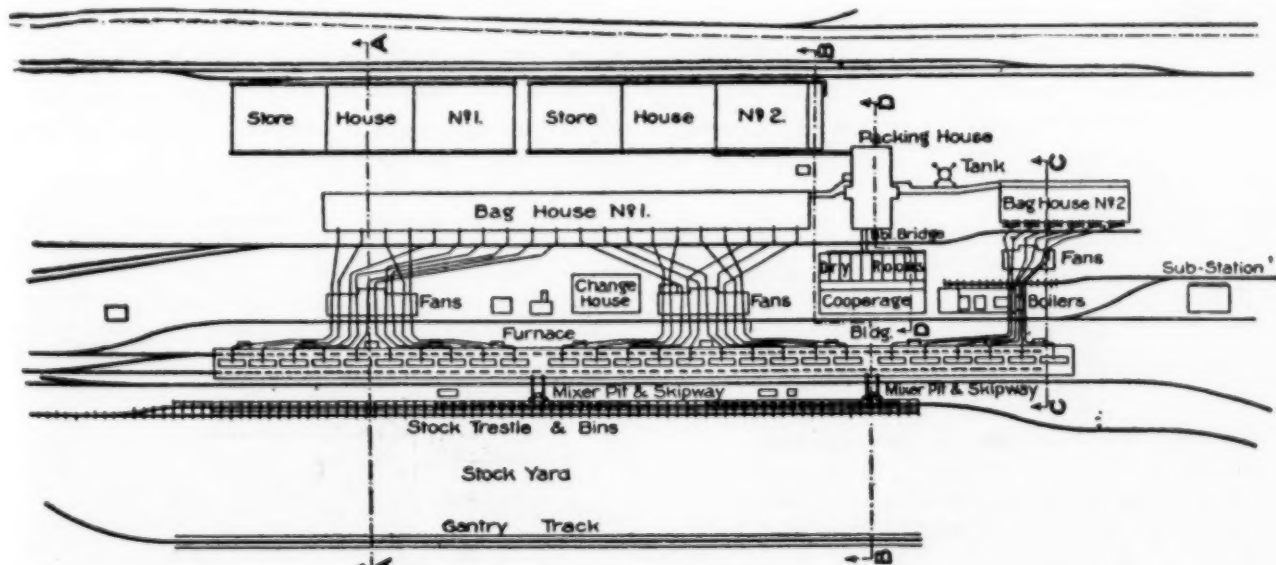


FIG. 2—PLAN OF EAST PLANT

doing all of the weighing at the mixer on a fixed hopper is more satisfactory than weighing larries, because the latter are very difficult to keep in adjustment.

#### FURNACE ROOMS

The furnace rooms at the two plants are quite similar, the main differences are that at the West plant the furnaces are carried on a concrete foundation and at the East plant on the floor. In both cases the furnaces are elevated sufficiently to allow the residue to be dropped into hoppers below the floor and then into cars. The framing of the buildings is quite different, the East plant (the later one) being arranged to give more room for the charge cranes. The West plant furnace room contains 34 blocks of furnaces and the East plant 26. All the blocks are alike, consisting of four furnaces 19 ft. 6½ in. by 5 ft. 11½ in. (Fig. 5). Each furnace has independent blast and flue connections and three charge openings in the roof surmounted by hoppers. Each furnace works three charges in 24 hr. The different furnaces of the block are charged alternately at 2-hr. intervals in regular order. Charging in this way, there is always one furnace starting, one nearly finishing and two working strongly, and the volume and temperatures of the gases to be handled are nearly uniform at all times.

#### FURNACE OPERATION

When the furnace is worked off the dampers in the flues are closed, cutting it off from the bag room. The blast is shut off and the working doors taken down. Three men work on the furnace at once, each having a separate door. The loose material on top of the charge is raked off and dropped on the floor close to the furnace. The clinker is then broken up by heavy slice bars and raked into hoppers under the floor. The furnacemen then thoroughly clean the side and back walls from any clinker that has fused to them. When all of the old charge has been removed and the furnace cleaned, the grate is covered as rapidly as possible with a thin layer of coal, the doors closed and a light blast turned on. The coal is lighted by the radiation from the hot arch and it is important that it should light quickly and evenly. When the bed coal is burning

brightly, the charge from the hopper is dropped up on it and leveled. The doors are now closed, the blast turned on and the furnace left to itself with occasional inspection to stop any blow holes that may form. With the large charges that are now worked, it is considerable time before any zinc vapor appears. When it does, the dampers in the flues are reversed, sending the gases and oxide to the bag room.

#### FANS AND PIPING

The blowers for the oxide furnaces are direct-connected to motors, the wheels of the blower being placed on extensions of the motor shaft. They are located in small houses outside the furnace room, two in each house.

Each furnace has two outlet pipes, usually 20 to 22 in. in diameter which lead up to the drum pipe overhead. The drum has an outlet in the middle of its length leading to the exhaust fans. Formerly the gases passed through a brick settling tower between the furnaces and exhaust fan, but this is now usually omitted as unnecessary. The exhaust fans are extra heavy plate fans with special Hyatt roller bearings and water-cooled shafts, belted to motors. Aside from the shafts, bearings and extra thickness of plate, they are of the ordinary types. For convenience in attendance, a number are placed in one building. The West plant has four fan rooms, three containing eight fans each and one containing ten fans. At the East plant there are two with ten fans each and one with six. From the exhaust fans to the bag rooms, in each case, run round pipes 3 ft. in diameter, made of No. 16 sheet iron and provided with numerous clean-out openings. In all cases, the pipes are arranged to give as nearly as possible the same length from furnaces to bag rooms. This is done partly to equalize the friction in the different lines, but mainly to secure proper cooling of the gases before reaching the bag room.

#### BAG ROOMS

The method of collecting oxide in bags was first patented by S. T. Jones in 1852 and has been patented by others many times since. The bag rooms at Palmer-ton vary considerably in size; the first two built hold-

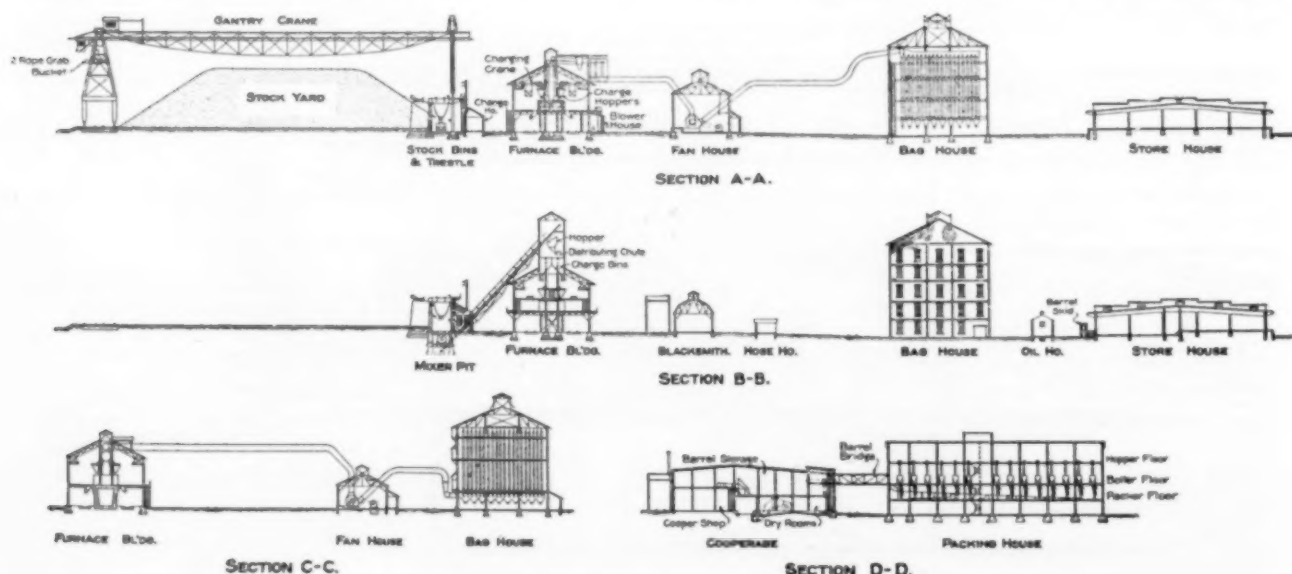


FIG. 3—SECTIONS OF EAST PLANT



ing bags enough for four blocks, while the latest contains the bags for twenty. The larger rooms are more economical in labor and do not cause any inconvenience, provided the ventilation is equally efficient. The bags used are all of heavy, closely woven cotton sheeting 22 in. in diameter and about 40 ft. long. In the majority of cases the gases enter a header at the top of the room and from there pass to a series of parallel pipes from the bottom of which the bags are connected to hoppers, four bags to each, with a single collecting bag tied to an outlet at the bottom of each hopper. At intervals the gases are shut off from the two lines of pipe connecting with a single line of hoppers and the bags shaken. This pair of pipes is again connected to the main header and the next two lines shut off and shaken. The frequency with which the bags are shaken depends upon the relative area of grate and bags, and the amount and quality of the oxide being made. The proper ratio of grate surface to bag surface has been a subject of much discussion. It varies in practice between 1:80 and 1:130. The amount actually necessary depends mainly on the efficiency of the ventilation of the buildings and the frequency of shaking. A well-ventilated room will consume no more muslin with a ratio of 1:80 than a poorly ventilated one with a ratio of 1:130. Recent experiments indicate the probability that a well-ventilated bag room with a mechanical shaker operating at short intervals will allow of a very great reduction in the necessary bag area.

The collecting bags are removed from the hoppers every 24 hr., or oftener if necessary, and taken to the packing room. This is done by a trucking gang that removes the filled bags and replaces them with fresh ones, trucking them by hand to one side of the bag room, where they are coupled together and the train drawn to the packing room by a motor.

#### PACKING

The packing room is a four-story building of mill construction. The trucks are hauled into the ground floor and then taken one by one on a platform elevator to the upper floor. There are a number of openings in this floor leading to bolters on the floor below. Around each opening is a wide shelf on which the bags are rested while their contents are emptied into the bolters.

The third floor contains nothing but the bolters, and a room for sewing and making bags. The bolters used are of the ordinary types used in flour mills. The packing machines are arranged in four lines on the second floor. They are also of a type largely used for flour. There is usually one packer below each bolter and fed directly by it. In some cases, owing to the lack of room, one bolter feeds two packers. The oxide is packed partly in paper bags holding 50 lb. each, partly in barrels with 30-in. staves and 19 $\frac{1}{8}$ -in. heads holding 300 lb. each, while export material is packed in special barrels and weights to suit the different markets.

The barrels are kept in a storage room where the hoops are driven by a machine and then nailed by a second one, and from here they are passed to the packers. All barrels are weighed empty and filled, the weights adjusted and the barrels headed. They are passed to the ends of the building and rolled on skids to the storehouses. The second floor of the packing room is high enough above the ground level to allow sufficient slope to the skids to carry the barrels to all but the most distant store houses. The paper bags are loaded on trucks and taken to the storehouses on the same skidways.

#### COOPERAGE

The cooperage is at the East plant, next the packing room. It is fully equipped with machinery and can manufacture about 2000 barrels a day. The barrels are delivered directly from it to the East plant packing room and by special railroad cars to the West plant storehouse.

The storehouses are all one-story mill-construction buildings with the floor elevated to the level of a box car. Each has doors and platforms on opposite sides, one for receiving material from the packing room and the other for loading cars.

#### POWER PLANT

Power for both plants is supplied from a central station at the West plant between the oxide and the spiegel furnaces. The boiler room is equipped with Edgemoor boilers of 536 hp. each, which can be fired with coal or with the waste gases of the spiegel fur-

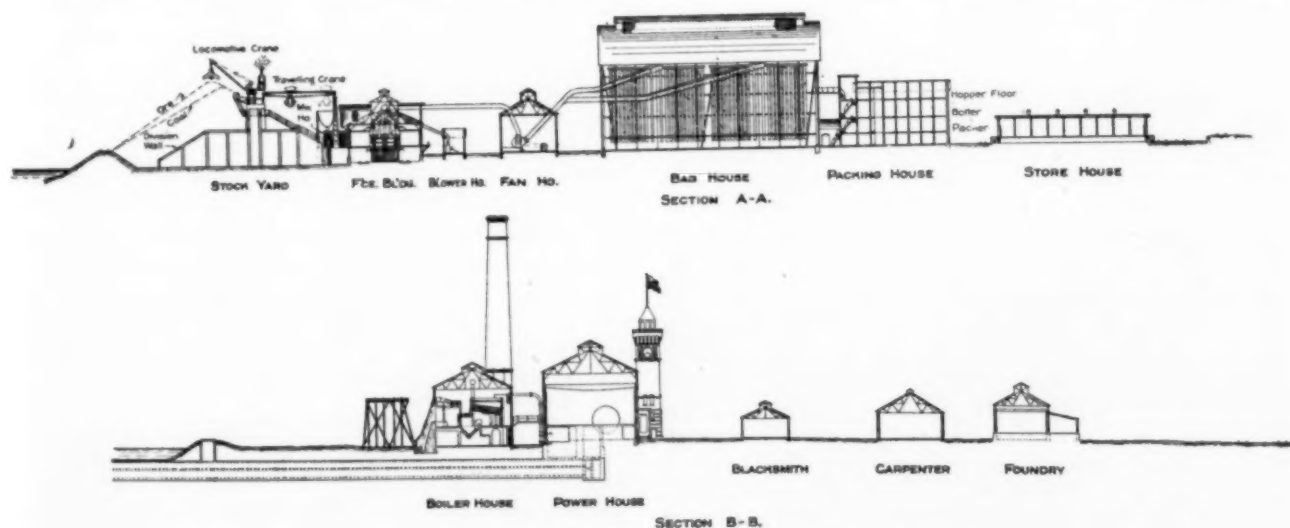


FIG. 4—SECTIONS OF WEST PLANT

naces. The engine room parallels the boiler room and is located about twenty feet north of it. It contains three horizontal cross-compound blowing engines for the spiegel furnace; four direct-current generators, two of 500 and two of 600 kw., each direct-connected to a horizontal cross-compound Corliss engine; three Allis-Chalmers turbo-generators, two of 2000 and one of 4000 kilowatts, 6600 volts, three phase; two motor-generator sets used as a reserve for both alternating and direct-current lines, as either part can be used as a motor to generate current of the other kind, if needed. In addition, the engine room contains the exciters, condensers and pumps. The engine room is entirely above ground, giving a light basement for the pipes and elevating the machinery above danger from floods. This also permits a railroad track to enter at the ground level, so that new machinery or repair parts can be brought into the building, and there lifted from the cars and put in place by a traveling crane that covers the entire space and can lift the heaviest piece of any of the machines. The switchboards are in a tower at the north side of the building, where they are visible from all parts of the generator floor, but do not project into the room. The tower gives ample room for leads and anchorages of cables.

#### ORES

The ores used at Palmerton are almost entirely concentrates from the company's mines at Franklin Furnace and at Sterling Hill, N. J. Three of these products are smelted for oxide: franklinite, half/half and dust. The composition of these is about as follows:

	Franklinite	Half/half	Dust
Zn .....	18.2	18.4	17.6
Fe .....	35.0	15.2	20.1
Mn .....	12.8	12.2	8.9
SiO <sub>2</sub> .....	3.6	12.6	7.2

The franklinite is worked by itself and the residue smelted in blast furnaces for the production of spiegel. The half/half and dust are mixed and the residue wasted, as it contains too little Fe and Mn and too much SiO<sub>2</sub> to be a profitable smelting material.

\* Franklinite is the easiest of these ores to work and gives the best product. The half/half and fines are mixed and worked together. The charges per furnace average:

	Ore	Coal
Franklinite .....	2.62T	1.62T
Half/half and fines .....	1.95	1.36

The recovery for franklinite averages about 86 per cent and for the half/half and fines charge about 78 per cent. Both charges and recoveries vary somewhat with changes in the ore and quality of the oxide desired. The recovery and quality of product are controlled by the selection of the ores, ratio between ore and coal and of both to the grate surface, and what is of great importance, the balance of blast and exhaust and the proper proportioning of both to the charge being worked. Where leaded ores are worked the charges and recoveries vary much more and average figures are of little value. In general, with such ores the charges are a little lighter and the recoveries lower than for the New Jersey ores. The recoveries of lead are usually rather better than of zinc, roughly as 9 to 8. For estimating purposes the make of oxide is generally

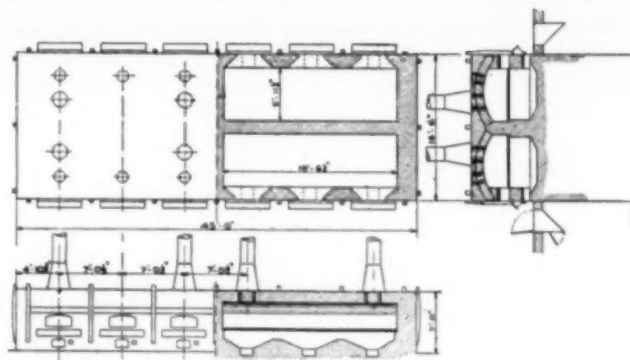


FIG. 5—FURNACES

taken as equalling the combined Zn + Pb in the ore, the gain in O and SO<sub>2</sub> about balancing the losses in Zn and Pb.

#### PRODUCT

The product is divided into five grades, two for the use of paint manufacturers, two for rubber and an off-grade that is reworked either for oxide or spelter. For the paint trade, the grading is entirely by color, samples being daily rubbed down with oil and compared with standards. For the rubber trade, slight variations in color do not make so much difference and the grading in this respect is not so close, but freedom from lead and absence of small hard particles is insisted upon.

The variation in composition of the different grades is very slight, the range of composition of all being nearly the same. The material as shipped uniformly contains 99 per cent or over ZnO, the principal impurities being: SO<sub>2</sub>, 0.25 to 0.33 per cent; H<sub>2</sub>O, 0.10 to 0.50 per cent, and PbO, 0.05 to 0.30 per cent.

The principal use of zinc oxide is as a paint pigment and for this purpose its purity of color and freedom from discoloration by gases and atmospheric conditions, fineness and uniformity make it particularly useful. As a pigment it has the disadvantage of slow drying and a tendency to become unduly hard in time. The general consensus of opinion among paint manufacturers now is that a mixture of pigments is better than any single one. In these mixtures, zinc oxide is an almost invariable constituent because it prevents chalking and gives a surface that retains its color.

Next in importance is its use in rubber goods. In the manufacture of such products, zinc oxide is used for two purposes. It is used as a pigment to produce white goods, and is excellent for this, provided it is substantially free from lead. If this were the only effect it had it might be replaced by cheaper materials, but it also greatly increases the tensile strength of the resulting material. A mixture of pure rubber and sulphur vulcanized has a tensile strength of about 2000 lb. per square foot and an elongation of 960 per cent of its original length. The effect of adding zinc oxide is to increase the tensile strength but diminish the elongation as shown in Table I.

TABLE I

Per Cent ZnO	Tensile Lb. per Sq. In.	Elongation, Per Cent
25	2,400	720
35	2,400	700
45	2,700	680
55	2,500	620
65	2,000	540
75	1,300	400

It will be seen that up to about 60 per cent, ZnO increases the tensile strength of rubber. No other material tested has this effect.

As the supply of lead-free ores is limited and the demand for ZnO is increasing, much more leaded oxide is being made. The process is the same but the charges are usually lighter and the recoveries lower. In most cases the furnaces used are double ended with one or two working doors at each of the opposite ends. This makes the furnace easier to clean, as there is no back wall, which is the most difficult part from which to cut accretions. On the other hand, this type of furnace cools off more when charging and does not, as a rule, light up as quickly. Which type is better is still an open question, the users of each claiming that theirs is superior. In making leaded oxide, it is customary to have a brick combustion chamber over, or close to, the furnace. This insures a sufficient time of contact at a proper temperature to cause the lead to be converted into basic sulphate. This is essential, as all of the oxides of lead are strongly colored and injure the color of the product, while the basic sulphate is very nearly white and does not have this effect. In many cases the bag rooms of the works making leaded oxide have no overhead distributing pipes, the hoppers being connected and used for this purpose.

Leaded oxide is divided into several grades, depending on the amount of lead it contains. This is always stated as the amount of neutral sulphate ( $PbSO_4$ ) equivalent to the total lead present, although it is always present mainly as a basic sulphate. It forms an excellent material for the manufacture of mixed paints. So far this grade has not proved satisfactory to the rubber manufacturers.

#### PRODUCTION

It is impossible to give production of oxide of zinc, as the statistics are not published by the Government. Such figures as have been published are not comparable, because the grouping of the different products is not always the same. The increase has been very rapid, especially within the last three or four years.

New York City.

**Club for American College Men in Paris.**—The establishment in Paris of a home club for American college men or their friends who may be in the French capital for military or other service in the cause of the allies is contemplated by the American University Union in Europe, which has just been organized in this country. The privileges of the club will include information bureau, writing and newspaper room, library, dining room, bedrooms, baths, social features, medical advice, etc. The union also expects to provide headquarters for the various bureaus already established or to be established in France by representative American universities, colleges, and technical schools. It will co-operate with these bureaus when established, and in their absence to aid institutions, parents, or friends in securing information about college men in all forms of war service, reporting on casualties, visiting the sick and wounded, etc.

The University Union will have its headquarters in Paris with branch agencies in London and such other cities in allied countries as may seem desirable. Its office in America will be in or near New York City.

## The Production of Salt in Szechuen Province, Western China—III

By H. K. Richardson

THE WELLS OF KWEI-CHOW FU

In two former articles\* the medium and deep salt wells of the province of Szechuen were described. This article will deal with the shallow wells, most particularly those at Kwei-Chow Fu.

Kwei-Chow Fu is situated on the Yangtze River just over the border in the Province of Szechuen as one travels up the river (see map in first article). The wells in question are situated 5 miles east of the town on both banks of the river. Those on the southern side are small and of little importance; the most important producer is a single well on the northern bank of the river. This well only operates a few months a year, for it is dug on the shingle bank of the river that is under water at the high stage of the river. When the river recedes in October the well is dug out and work continues night and day, no stopping on Sunday, until the spring freshets in April inundate the bank carrying stone and gravel into the well hole and filling it up. The sides of the well are made of permanent stonework, so that all that is needed the next season is to locate the well and clear out the debris and make a few repairs to the retaining wall. Fig. 1 shows the situation of the well on the river bank, surrounded by the shacks in which the workers live during the season. The evaporators are all nearby the well, so there is always steam arising from the settlement, while by night the light of the many fires makes one think of a small steel village.

The well is an open pit some 35 ft. deep and about the same in diameter. The well or spring itself is enclosed by a stone facing 12 by 12 ft., which also serves as the landing stage from which the brine is dipped into the coolies' buckets. Fig. 2 shows a general view of the well. Access to the bottom is obtained by three flights of stairs made of stone and worn smooth by many years of use.

All the brine is carried to the top in buckets by coolies. Figs. 3 and 4 show the coolies lined up to fill their loads. Fig. 3 was taken when brine was plentiful, so no one was afraid of not getting his share, while Fig.

\*The Journal, Jan. 1, 1917, and Sept. 1, 1917.



FIG. 1—SALT VILLAGE ON NORTH BANK OF YANGTZE RIVER, 5 MILES EAST OF KWEI-CHOW FU. SHINGLE BANK IN FOREGROUND IS COVERED AT HIGH WATER. RIVER FLOWS AT FOOT OF MOUNTAIN IN BACKGROUND





FIG. 2—BOTTOM OF WELL. GENERAL VIEW, SHOWING RETAINING WALL AND FLIGHT OF STEPS. COOLIES CARRYING BRINE UP STEPS. LANTERN SLUNG ACROSS FOR NIGHT WORK

4 was taken at a time when brine was scarce and everyone was after more than his share. In the latter photo about a dozen naked men were down in the well scooping up the brine with a bucket and filling those of the coolies. The brine when brought to the top of the well is dumped into a half-barrel containing pebbles; the brine overflows from this head tank into wooden sluiceways 5 in. wide by 3 in. deep, and finds its way to the evaporators. Fig. 5 shows the edge of the head tank



FIG. 3—BRINE PLENTIFUL—WATCHING THE FOREIGNER MORE THAN THEIR JOB



FIG. 4—BRINE SCARCE—EVERYONE BUSY AS BEES TO GET HIS SHARE. NOTE BUCKETS ON CARRYING POLES

and the sluiceways. Each evaporating unit consists of a storage pond, two filters and three evaporating pans and their furnaces. The brine coming along the main sluiceway is shunted to the respective ponds by a valve of hard clay balls. The storage pond is made by hollowing out a depression in the hard clay and hammering the clay solid. Sometimes lime is added to the surface of the clay. These ponds are 20 ft. long, 12 ft. wide and 2 ft. deep.

The brine from the storage pond is dipped into two filtering barrels, these barrels being filled with clay balls about 2 in. in diameter. Some of these balls are in reality salt brick. In seasons of plentiful supply of brine some of the brine is poured out over the clay surrounding the chimney of the furnace and all the water evaporated off. This process is repeated until the clay is saturated with salt and becomes very hard when it is broken up into the clay balls above mentioned. Fig. 6 shows one of these chimneys. These clay balls are then stored against the time when the well fills, and there is a little interval that the pans can be worked before they are flooded. They also serve as the filtering material, cleaning out the dirt and also leaching out their contained salt, thereby increasing the degree of saturation of the brine and increasing the fuel economy. Their use is apparently unique in this well, and is a fine illustration of efficiency of operation and ingenuity in making the best of a situation.

The clear brine is piped from the filters to the first evaporating pan, into which it drips constantly. Here it is concentrated until salt appears around the edges, when it is dipped over into either of the other two pans. From these two pans the crystals are constantly



FIG. 5—HEAD TANK TO SLUICWAYS. GRAVITY FEED TO STORAGE TANK AT EVAPORATING PANS



FIG. 6—CLEANING OF PANS. MAKING SALT BRICKS

collected and allowed to drain in a V-shaped wooden trough. Fig. 7 shows a top of a pan and the crystal drainer. When the layer of salt formed on the bottom of the pan slows up the evaporation too much the brine is allowed to evaporate to dryness and the hard salt cake is removed and sold for distant traffic.

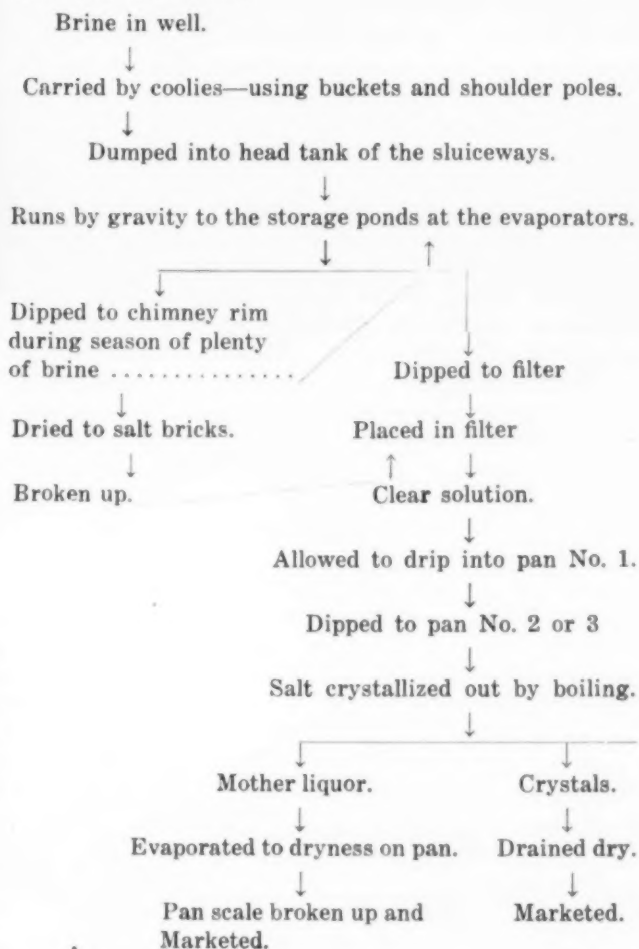
Each pan is set over its own furnace, which is very simple in construction; a hole 6 ft. in diameter and 7 ft. high is dug in the ground and lined on three sides with pounded clay, the front or fire side being closed up with mud brick or stones. The furnace is carried up 4 or 5 ft. above ground and tapered in to receive an iron pan 3 or 4 ft. in diameter. The pan is made of cast iron  $\frac{1}{8}$  in. thick and is 9 to 12 in. deep in the middle. This pan is carefully luted on the top of the furnace, so that all smoke must pass out of the holes at the back of the furnace and up through the chimney described above. Fig. 8 shows the fire side of one of these furnaces. The fire bed is about 8 ft. below the bottom of the pan, allowing of complete combustion of the fuel.

The fuel used in these furnaces is a slack coal mixed with mud to make briquettes. The coal of this region is mined several miles up a small stream and floated down in small boats. Since the coal is very friable there is much small material; this fine stuff is mixed with considerable amounts of clay and made into briquettes 3 by 2 by 5 in., which are sun dried and then used. They make a good fire that burns slowly and evenly. Their most important objection is the amount of sulphur dioxide given off. Fig. 9 shows one of the numerous briquette factories, or rather yards, on the beach. A careful look at the picture will disclose the entire mixing and molding outfit.



FIG. 7—EVAPORATING PANS AND STRAINERS

The operations of the plant are best seen from the following flow sheet:



The well is the property of 100 families, who share the ownership of the well on the community idea, and all others must keep out. Each family erects its own straw hut on their section of the beach at the beginning of the year's season and the whole family helps in the work, living on the spot. Each family sections off its pans, storage ponds and hut from the others. Each family does its share in cleaning out the well at the beginning of the season, and must share in the building of the sluiceways to its pans. There is no charge made for the brine, each family hires the number of coolies it needs to supply its pans and then they have regular shifts for the day and night work. Each family is entitled to the use of four evaporating pans, however



FIG. 8—FIRE SIDE OF FURNACE—CHARGING DOOR FOR COAL

the average per family is only three, making about 300 pans in operation.

The brine obtained from the well is very weak; the owner of one of the pans told us that he recovered only 6 to 8 oz. per load of brine; this would mean about a 0.4 per cent solution of sodium chloride. He also stated that he produced 120 or 110 or 100 catties of salt per day and night per pan, depending on how long the pan had been run and how thick the pan scale became. When they only produced 100 catties the pan scale was removed and the pan started over again. The average yield per three pans per day was 340 catties or 453 lb. of salt ready for the market. This same man gave us the figures of 2133 lb. of coal used per 133 lb. of salt produced. This would give 15.6 lb. of water evaporated per pound of coal; this would be too high if only the weak brine is considered, but since bricks are extracted and the brine strengthened this figure is unreliable for calculating the evaporation of water.

The balance sheet of this operator is of interest.

INCOME PER MONTH	
13,600 lb. of salt at 2c per lb.	\$272.00
EXPENDITURES PER MONTH	
Labor—6 brine carriers at \$2.00 per month	\$12.00
—3 furnace men at \$4.00 per month	12.00
Food for the above nine men	7.20
Coal—108.8 tons at \$0.87 per ton	\$94.66
Salt tax at $\frac{1}{2}$ c per lb.	68.00
Depreciation of pans and repairs:	
Cost of furnace	\$13.00
Cost of furnace pans	3.00
	\$16.00
In use for 7 months then furnace total loss, pans salable for other purposes at low price so assume a total loss	2.29
Monthly profit	\$196.15
	75.85

Out of the above profit we can justly deduct the slight cost of marketing the salt, the cost of erecting the buildings each year, the annual cleaning out of the well, and the erecting and taking down of the sluiceways, etc., each year. These all told should not exceed \$50 in a season, so with a gross profit of  $7 \times \$75.85$ , or \$530.95, there is still a net profit of \$480.95 per season. This is a princely sum for a Chinese family, and does much to explain the care with which the family watches the work. It is very probable that considerable graft or "squeeze" money was paid to officials from the net profits. There is practically no permanent investment, since the pans and furnaces are used only seven months a year and then lost under the rising waters of the river.



FIG. 9—BRIQUETTE YARD ON RIVER BANK AT KWEI CHOW FU

There are two other shallow wells that supply a much larger amount of salt than that at Kwei Chow Fu. These are the wells at Yun Yang Chang and Da Ning Chang. As far as I know these have been visited by only one white man, Rev. Mr. Hannah of the China Inland Mission of Kwei Chow Fu. The following data was given to the writer by Mr. Hannah:

#### WELLS AT YUN YANG CHANG, 7 MILES NORTHWEST OF YUN YANG HSIEN

The wells are about 10 to 20 ft. in diameter, walled with stone down as far as can be seen. They vary in depth from 100 to 200 ft. The brine is raised in small buckets holding 2 gals. Two buckets are attached to the end of a rope, the rope thrown over a sheave so that when an empty bucket descends to the well a full bucket ascends. At the large wells there are twenty to thirty of these windlass lifts arranged around the periphery of the wells; they are manned by coolies stripped to the waist. Each coolie has a rope around his waist to prevent him from falling into the well. The brine evidently comes from an underground spring and is very clear, needing no filtration. Coal from an adjoining hillside is used to evaporate the brine.

#### WELLS AT DA NING CHANG, 10 MILES FROM DA NING HSIEN

The brine at this place is obtained from a spring on a hillside. The spring is a hole about 4 ft. in diameter; the brine flows from the spring by gravity directly into a large concrete (Chinese style) reservoir. From the reservoir bamboo tubes lead the brine directly to the evaporating pans situated on the hillside at a lower level. The brine is allowed to run continuously into the pans. The brine is clear and needs no filtration. Coal is used as at Kwei-Chow Fu for the evaporation.

The relative productions of the various classes of wells is obtainable from data collected by Sir A. Hosie in 1904. The data given below is from his compilation for 1902 or 1903:

Type of Salt Well—Situation	Production Catties (1.33 lb.)
Deep wells, 3000 ft. over:	
Tzu Liu Tsing	274,000,000
Medium wells, about 1000 ft.:	
Chien Wei Hsien and Klating Fu	141,100,000
Tai Ho Chen district	2,700,000
Chien Chow district	7,300,000
Unclassified, mostly medium wells	5,000,000
Total	156,100,000
Shallow wells, 200 ft. and under:	
Yun Yang Hsien	25,500,000
Da Ning Hsien	9,900,000
Kwei Chow Fu	2,700,000
Yen Yuan Hsien	1,300,000
Total shallow	39,400,000
Grand total	469,500,000

Changing the above figures to American tons we get the following table:

Type of Well	Tons of Salt	Per Cent of Total
Deep wells over 3000 ft. deep	182,600	58.3
Medium wells, mostly about 1000 ft.	104,100	33.3
Shallow wells, mostly under 200 ft.	26,300	8.4
Total	313,000	100.0

The value of the 313,000 tons of salt at 2 cents per pound is \$12,520,000, which is a considerable yearly business even in U. S. A., and means a very large business in a country like China. It would be hard to estimate accurately the number employed in this industry, but it cannot be far from 1,000,000 hands.



## The Milling Practice of the St. Joseph Lead Co.\*

BY L. A. DELANO,<sup>1</sup> E. M.

During 1916, the St. Joseph Lead Co. milled 2,505,670 tons of ore. This is a daily operating average of 7855 tons. The economic concentration of such a large tonnage necessarily requires a plant equipped with modern machinery and operated efficiently. The milling process used in producing this output has been a gradual de-

\*A paper to be presented at the St. Louis meeting of the American Institute of Mining Engineers, October, 1917.

<sup>1</sup>Mill Superintendent, St. Joseph Lead Co.

<sup>2</sup>Trans. A. I. M. E. (1888-89), 17, 659.

velopment through the long period of years that the company has been in existence.

## HISTORICAL SUMMARY OF MILLING PRACTICE

Ore was first mined at Bonne Terre, Mo., in 1864. The early milling practice was crude. It consisted of breaking the ore into small pieces by hand, pulverizing in a Blake crusher and a pair of Cornish rolls to approximately minus 6 mm., and jigging in the old-fashioned hand jigs. Only the coarse heavy galena was saved, the gangue being shoveled off and discarded. The output for the first year under this method was only 240 tons of pig lead.

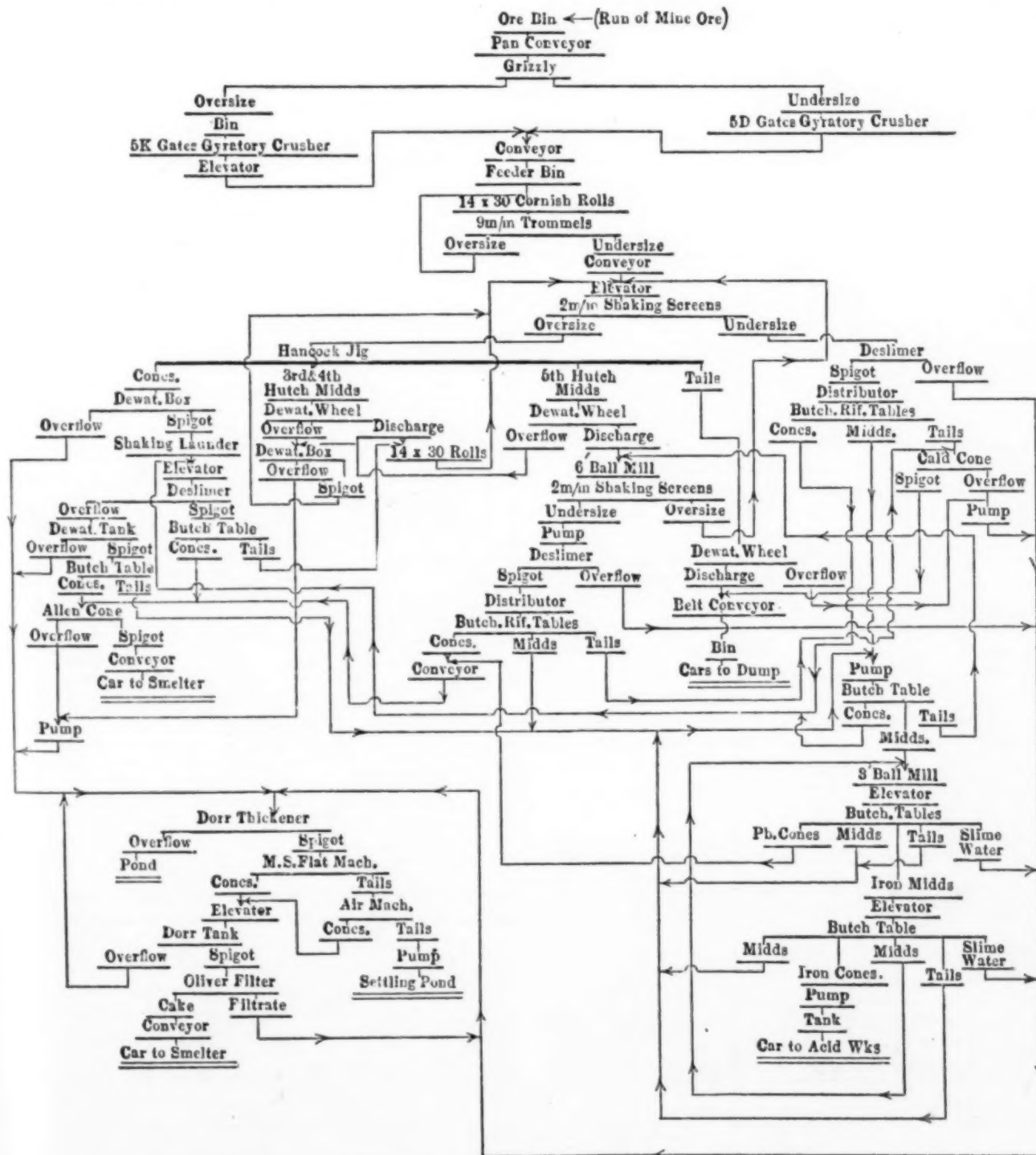


FIG. 1—FLOW SHEET BONNE TERRE MILL



In 1909, the Doe Run Lead Co., now a subsidiary of the St. Joseph Lead Co., built a 2400-ton mill at Rivermines, Mo., which in 1913 was enlarged to handle 3600 tons per day. This plant received ore crushed to 4 in. at the mines, and, after reducing to 9 mm. at the mill, concentrated it on Hancock jigs and Wilfley tables.

In 1912, the Bonne Terre mill was partially remodeled, Hancock jigs, Richards classifiers, and automatic disposal of mineral and chat were installed, increasing the capacity of the plant to 1600 tons daily. In the spring of 1914, the flotation process having been applied to lead ores by the Federal Lead Co., it was installed in the three mills of this company for the treatment of the slimes. The application of modern crushing machinery, jigs, tables and flotation has resulted in the present system of milling with the ability to handle large tonnages economically.

#### DESCRIPTION OF THE PLANTS

The ores are milled at three plants, namely, Bonne Terre, Leadwood and Rivermines. Daily tonnages milled at each plant are: Bonne Terre, 2100; Leadwood, 1750; and Rivermines, 4000.

The mineral, galena, is disseminated in magnesian limestone or dolomite. It is associated with some pyrite, marcasite, chalcopyrite and sphalerite, and carries a small amount of silver. The ore in part of the mines runs high in chlorite (glauconite), and contains a rather large percentage of insolubles. The galena is massive, crystalline to fine granular in character and disseminated in the dolomite. The ore has a specific gravity of approximately 2.8, and a hardness of 3.5.

The flow sheets of the three mills are shown in Figs. 1, 2 and 3. In this paper a complete description of the Bonne Terre mill practice will be given, and then contrasted with the operation at the Leadwood and Rivermines mills, showing the principal differences in each plant.

#### THE BONNE TERRE MILL

The ore is hoisted to a bin of approximately 22 tons capacity. From this bin it is conveyed by pan conveyors to two No. 5 style D Gates and one No. 5 style K Gates gyratory crushers. A screen analysis of run-of-mine ore feeding the crushers is shown in Table 1.

TABLE 1—SCREEN ANALYSIS OF ORE AT THE BONNE TERRE MILL

Size	Per Cent Weight
On 10 mesh	11.1
On 8 mesh	12.6
On 6 mesh	7.6
On 4 mesh	32.5
Through 4 mesh	36.2
Total	100.0

Grizzlies with bars spaced with 7½-in. clearance are set on an incline over the two No. 5 D crushers that crush the undersize. The oversize gravitates to a small bin and is crushed by the No. 5 K crusher, and is then elevated by bucket elevator to pan conveyors, which convey all the crushed discharge to belt conveyors. These belt conveyors distribute the ore to feeder bins, scrapers being used to rake it off into each bin. Messiter electric scales attached to the pan conveyors receiving the discharge from the crushers were used for a time, but have been discontinued because of difficulty in keeping them accurately regulated. Table 2 shows a screen analysis of the crusher discharge.

The same Cornish rolls that were installed in the mill

TABLE 2—SCREEN ANALYSIS OF CRUSHER DISCHARGE

Opening Diameter	Weight, per Cent	Opening Diameter	Weight, per Cent
+3 in.	12.9	+1 in.	14.9
+2½ in.	11.4	+9 mm.	12.5
+2 in.	17.6	+2 mm.	9.9
+1½ in.	15.7	+150 mesh	3.5
		-150 mesh	1.6
		Total	100.0

when it was built in 1883 are still in use. Thirteen sets are used, fed by Challenge feeders. The shells are 14 by 30 in., one chilled cast iron and the other chilled steel is used on each set. A groove ¾ in. deep and 1½ in. wide is cut across the face of each steel roll shell to prevent slipping of the ore and consequent grooving of the shell. The roll speed is 10 r.p.m. Weight boxes are used on the rolls instead of springs. The roll discharge is screened through a 9-mm. trommel, 3 ft. diameter by 8 ft. long, with a slope of 1 in. per foot. The trommel revolves at a speed of 36 r.p.m. The oversize is returned by a bucket elevator to each roll. The rolls average 185 tons per 24 hr., and have shown by test that 250 tons per hour can be maintained. The rolls are driven by two 75-hp. and one 100-hp. motors with a total load of 210 hp., or an average of 16 hp. per roll, including the oversize return elevator.

#### THE CONCENTRATION SYSTEM

The mill is divided into four sections after crushing the ore, an equal tonnage being treated in each section. The mill building is built on a level site and it is necessary to elevate and pump the various products for treatment. All line shafts are near the basement floor, together with the rolls and other heavy machinery, set on concrete foundations. The undersize from the 9-mm. trommels is conveyed to elevators and water added to sluice the ore into the boots. The elevators are 53-ft. centers, using 8 by 16-in. buckets with a belt speed of 400 ft. per minute. The discharge from the elevators is screened on 2-mm. screens.

The screens are of the Ferraris shaking type, first used by the Desloge Lead Co. in this district, but have been redesigned at Bonne Terre to withstand the service required and to fit the limited head room. The screens are made at the plant, and cost about \$125 each, erected. Three screens are used at each elevator, driven separately from a line shaft, so that repairs can be made, or screen sheets changed, while the other two carry the load. The screen frame is supported by hickory hangers set at an angle of 65 deg. to the frame. The drive-rod is connected to the head of the screen and a jig eccentric on a countershaft over the screen supports. The eccentric is set for 1¼-in. stroke and a speed of 270 to 290 r.p.m. A clear-water spray is used over the screen near the center to wash the fines from the oversize. Various screen openings have been tried, but at present 2-mm. round holes in No. 18 gage sheets are used, the sheets lasting about 40 days. Each screen treats 250 to 300 tons per 24 hours and requires 0.75 hp.

#### THE JIG INSTALLATION

The Hancock jigs treat the oversize of the 2-mm. screens. They are divided into five hutches and a tail compartment. The first and second hutches produce





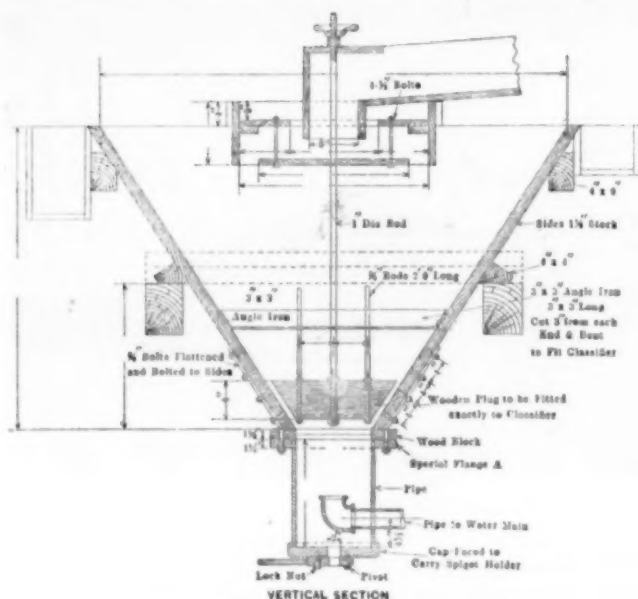


FIG. 4—THE DELANO DESLIMER

As final results had not been worked out on either type of mill at the time of writing, it is possible to give only some of the experimental data at present, showing the grinding efficiency and tonnages treated by each mill.

Results with the Hardinge mill are shown in Table 3.

TABLE 3—Data on Hardinge Mill Operation

Average tonnage ground . . . 250 tons per 24 hr. (this includes 50 tons of middlings returned from table treatment).

Ball load.....	14,000 lb.
Kind of balls...	Cast iron, with 3 in. maximum diameter.
Power required.	53 hp.
Speed of mill...	30 r.p.m.
Moisture.....	50 per cent.
Ball consumption	0.9 lb. per ton crushed

The following screen analysis in Table 4 shows the crushing performed on this class of material.

The discharge from the mill is screened through a 2-mm. shaking screen. The oversize returns to the jig elevator as jig feed, and the undersize is pumped to a deslimer for table and flotation treatment.

Various tests have been tried in crushing by the Hardinge mill, *e.g.*, crushing the entire middlings, returning the oversize to the jig and the undersize to tables and flotation. This method enriched the flotation feed too much, due to the rich middlings from the third and fourth hutches of the jig. Another test was to crush the entire tailings of the jig, the middlings being crushed in the rolls and returning to the elevator, and the oversize of tailings from the ball mill being discarded as chat. The ball mill lacked capacity to treat the necessary tonnage in this manner, and it was found that the most economical method was to crush the middlings from the fifth hutch of the jig. This gave low tailings on the jig and low-grade slime for flotation, besides allowing a larger tonnage of ore to be treated in the mill section.

## THE ALLIS-CHALMERS GRANULATOR

This mill has a grate through which the crushed product must pass before being discharged. As with the Hardinge mill, various tests are being made to

TABLE 4—SCREEN ANALYSIS OF HARDINGE MILL MATERIAL

FEED			PRODUCT		
Mesh	Per Cent Weight	Cumulative, per Cent Weight	Mesh	Per Cent Weight	Cumulative, per Cent Weight
On 3	5.34	5.34	On 4	1.1	1.1
On 4	15.00	20.34	On 6	1.3	2.4
On 6	12.45	32.79	On 8	2.0	4.4
On 8	17.45	50.24	On 10	5.8	10.2
On 10	15.60	65.84	On 14	6.4	16.6
On 14	10.27	76.11	On 20	6.6	23.2
On 20	4.49	80.60	On 28	7.8	31.0
On 28	2.29	82.89	On 35	6.9	37.9
On 35	1.52	84.41	On 48	6.6	44.5
On 48	1.95	86.36	On 65	5.8	50.3
On 65	2.46	88.82	On 100	7.8	58.1
On 100	3.98	92.80	On 150	8.4	66.5
On 150	5.25	98.05	On 200	8.8	75.3
On 200	1.10	99.15	Through 200	2.47	100.0
Through 200	0.85	100.0			
Total	100.00			100.00	

determine its crushing capacity, efficiency, etc. The first tests were to crush the jig tails, cast-iron balls with 3-in. maximum diameter being used as grinding mediums. Ball loads ranged from 9000 lb. to 14,000 lb., but the results were not satisfactory, the tonnage building up in the mill and choking it. Raising the pulp level improved the grinding slightly. It was found, however, that the balls broke up badly, so a change was made to forge chrome-steel balls of large diameter. Tests for ball charges, load and pulp level have resulted in gradually raising the tonnage of feed and grinding efficiency. The results shown in Table 5 are the best that have been obtained as yet, further tests being made with a closed circuit.

TABLE 5—ALLIS-CHALMERS BALL GRANULATOR RESULTS

Character of feed .....	Jig tails and fifth-butch' middlings
Ball load .....	12,000 lb. (consisting of 100 lb. of 5 in. diam., 3000 lb. of 4 in. diam 3000 lb. of 3 in. diam.)
Revolutions per minute .....	23
Grate opening .....	4 in.
Pulp-level distance from center .....	16 in.
Tons feed per 24 hr. ....	486
Per cent moisture .....	62.6
Horsepower .....	59.4
Tons crushed through 2 mm. per horsepower .....	6.7
Oversize of 3-mm. screen discarded as chat.	
SCREEN ANALYSIS OF PRODUCT	
Mesh .....	Per Cent Weight
On 10 .....	18.7
On 150 .....	62.7
Through 150 .....	18.6
Total .....	100.0

The discharge from the mill for a while was screened through a 2-mm. screen, the oversize being discarded as chat. Later a 3-mm. screen was substituted, resulting in the table tailings averaging practically the same as with the smaller opening. The oversize of this screen was also discarded, but is now being returned to the jig feed, making a closed circuit on the ball mill. Results from this at present are not complete.

## SUMMARY OF BALL MILL PRACTICE

It is impossible now to give final results metallurgically as to the effect of ball mills on the milling practice of the ores. However, an increased capacity for the plant is obtained when the middlings are taken from their former closed circuit with the jig and recrushed in ball mills. The undersize of the ball-mill discharge is deslimed, the sands going to separate tables. This gives the jig capacity for more original ore, and the plant now handles 2300 to 2400 tons per day. This



FIG. 5—DOE RUN LEAD CO.'S MILL, RIVERMINES, MO.

alone has justified the installation of the ball mill. On the other hand, rolls cannot grind the low-grade middling as well as the ball mill, the latter giving more material for tables and flotation, which result in lower tailings than the jigs. The regrinding of jig tailings has resulted in lowering the final tailings. Approximately 60 per cent of the feed to the Allis-Chalmers ball mill is sent to tables, the tailings of which average less than 0.4 per cent Pb. The flotation plant receives 18 per cent of the feed and will make minimum tailings there. The tests have not been completed to show the economic effect of lowering the mill tailings, but the results point toward a profit, even with a low-price lead.

## TABLE CONCENTRATION

In the summer of 1915, it was decided by the management to give the Butchart riffing a trial in table practice, in order to increase the tonnage and efficiency of the mills. A series of tests were carried out for several months at the Bonne Terre mill to determine the best application of the riffle to the treatment of these ores.

Previous to this time, Wilfley tables and riffing had been used, the feed to the tables being the spigot products of Richards four-spigot, vortex classifiers. The Butchart riffing worked best, however, with deslimed sands, no separation into different sizes being required. As it became necessary to mix the spigot products of the classifiers, it was decided to change the classification system.

Experiments were conducted to produce a one-spigot classifier that would handle the entire tonnage of the undersize from the 2-mm. shaking screens and deslime it so as to give a table feed practically free from the minus 150-mesh slimes. The experiments resulted in a one-spigot, two-product, hydraulic classifier, or deslimmer, with an inverted conical or pyramidal tank, the entire perimeter being used for the overflow into a surrounding launder at the upper edge. The deslimmer is provided with a central feed box, having a baffled bottom to break the velocity of the inflowing pulp. The bottom, or discharge chamber, has a clear-water inlet, which directs the flow upward along the axis of the deslimmer. The spigot is inserted in a movable holder, attached to the bottom of the discharge chamber, permitting an instant change in the diameter of opening without wetting the operator. Between the feed box

and discharge chamber is a valve with sides parallel to the tank and suspended on the vertical center, and which can be raised or lowered by means of a hand wheel on the suspension rod. This produces a narrow channel between the valve and tank through which the hydraulic water rises and the sands fall.

The feed entering the deslimmer is checked by the baffle, causing the sands to settle through a narrow, rising current of water surrounding the valve. This current increases in velocity until the discharge chamber is reached, by which time the sands are thoroughly deslimed. A hydraulic pressure of 5 or 6 lb. per square inch is maintained in the discharge chamber. The width of the sorting column may be varied by raising or lowering the valve. No whirling or boiling currents are possible and the steady rising current gives a very close separation. The great efficiency of the deslimmer is due to the better application and direction of hydraulic water supplied. A deslimmer 5 ft. 6 in. in diameter treats from 350 to 400 tons per 24 hours, using approximately 120 gal. of hydraulic water per minute.

TABLE 6—SCREEN ANALYSES OF DESLIMER MATERIAL

FEED		Spigot, per Cent Weight	Overflow, per Cent Weight
Mesh	Per Cent Weight		
On 100.....	64.70	86.8	0.69
On 150.....	7.41	8.2	5.16
On 200.....	4.10	2.3	9.32
Through 200.....	23.79	2.7	84.83
Total.....	100.00	100.00	100.00

Experiments with the Butchart riffing were carried out with the following objects in view, viz., to determine size and character of feed, to increase the table efficiency, increase its capacity, simplify the flow sheet, reduce water consumption, power and labor. Its ability to treat unclassified material gave it advantages over the Wilfley riffing by eliminating the multiple-spigot classifier. The concentrates are discharged at the upper edge of the table, the coarser particles being in the upper riffles instead of mixing with the middlings, as in the Wilfley riffing. This gives a larger capacity for both the concentrates and middlings separation and enables much larger tonnages to be treated per table.

Tests were made with feed ranging from minus 9 mm., or jig feed, to the finest sands. In each case the





FIG. 5—DOE RUN LEAD CO.'S MILL, RIVERMINES, MO.

riffling was made especially for the size of feed treated. The separation of free galena as concentrates in each case was satisfactory, but in the coarser sizes the separation of the middlings from the gangue was imperfect and would have necessitated recrushing the entire tailings for retreatment. Final tests showed that the jigs gave a better separation of tailings and middlings on material from 9 to 2 mm., while the undersize of 2-mm. screens deslimed to remove the minus 150-mesh slimes, and treated on tables, gave satisfactory results.

With this size of feed the tables now treat from 50 to 60 tons per day, giving clean concentrates and as low tailings as with the Wilfley when treating 20 to 25 tons per day. In operation, the table requires very little adjustment, even with the load varying 5 or 10 tons. The riffling used in this work tapers from 7/16 in. to 1/8 in., with a slope of 1 in 4 in the cleaning zone. The middlings average approximately 10 per cent of the feed to the tables. This is retreated on a separate table for two mill sections, the tailings being reground in the 6-ft. ball mill. A concentrate cut is made from this table and the middlings are reground in a 3-ft. Hardinge mill and sent to another circuit.

In changing the mill from the Wilfley to the Butchart system, one Butchart table replaced three Wilfley tables, and resulted in a saving in power, labor and water. Various pumps, launders, classifiers and settling tanks were also cut out, making a much simpler flow sheet in this mill.

The possibility of using the Butchart riffling to raise the grade of the mill concentrates was suggested by its large capacity and its ability to treat coarse material, discharging the coarsest particles at the upper edge of the table. The jig concentrates were erratic, ranging from 60 to 70 per cent Pb, and occasionally going lower. Before this they had been washed in a log washer or trunking machine, which made a rather poor separation. Tests with the Butchart riffling showed that the feed should be deslimed and treated on two tables. The spigot of the deslimer—or plus 100-mesh material—was treated on one table, and the overflow, or minus 100-mesh material, was settled in a tank, the spigot feeding the second table.

Table concentrates were mixed with the jig concentrates to produce a mixture of sizes that would bed well on the table. The riffling on each table was especially arranged for the size and character of the feed. The

coarse galena was discharged in the upper riffles, followed by the finer sizes. A good separation was made in the cleaning zone, the tailings constituting true middlings containing practically no free galena. They averaged 25 to 35 per cent, and are recrushed in the jig-middling rolls, returning to the circuit by the jig elevator. The coarse table now treats from 70 to 100 tons per day and has capacity for a larger range in tonnage.

The fine-table concentrates averaged 80 per cent Pb, 95 per cent passing a 200-mesh screen. The tailings average 6 per cent Pb, and are returned to the sand middlings table.

At present the entire jig concentrates and a portion of those from the tables are treated in the recleaning system. The grade of the mill concentrates has been raised from an average of 68 per cent to 73.5 per cent, resulting in smaller freight and smelter treatment charges, and without affecting the mill recovery.

#### CONCENTRATES DISPOSAL

The concentrates from the entire mill are sent to a 60-ft. Allen cone for dewatering. The spigot discharges on a conveyor belt to the car, while the overflow returns to the mineral elevator.

The jig-tailings disposal was referred to in describing the jigging. The tailings from the tables are dewatered by Caldecott cones, the sands discharging through the spigot to the chat conveyor. The cones will average from 400 to 500 tons of minus 2-mm. sands per day, the average moisture in spigot being 28 per



FIG. 6—FLOTATION MACHINE, RIVERMINES MILL



FIG. 7—ST. JOSEPH LEAD CO.'S BONNE TERRE PLANT

cent. A screen analysis of the spigot discharge is shown in Table 7.

TABLE 7—CALDECOTT CONE SPIGOT DISCHARGE

Mesh	Per Cent. Weight	Mesh	Per Cent. Weight
+10	2.59	+65	7.27
+14	9.61	+100	6.65
+20	17.64	+150	5.18
+28	22.95	+200	1.25
+35	15.13	+200	0.86
+48	10.87		
		Total	100.00

The sands from these cones, and the shovel-wheel discharge, or jig tailings, are conveyed by a 20-in. conveyor to a concrete chat bin with a capacity of 250 tons. Railroad cars of the A-dump type run under this bin, and are loaded by slide gates in the bottom of the bin, and sent to the chat dump. A portion is sold for railroad ballasting and concrete work.

#### THE PYRITES CONCENTRATES

The ore assays approximately 5 per cent Fe, consisting mainly of pyrite, marcasite and chalcopyrite. This is concentrated in the table middlings and requires fine grinding to separate the galena, pyrite and dolomite. The middlings from the sand tables are reconcentrated on a middling table and the middlings from this table

are sent to a 3-ft. Hardinge mill for regrinding. The mill is operated with a 1000-lb. ball load, replenished with 2-in. cast-iron balls. The product will nearly all pass a 65-mesh screen, and is elevated to a Butchart table. Lead concentrates, assaying 80 per cent, are sent to the Allen cone and middlings are retreated on another Butchart table, which produces galena-pyrites concentrates. The analysis of concentrates shows an average of 41 per cent sulphur, a portion being shipped to a sulphuric-acid plant for experimental purposes, with a view to recovering the sulphur as acid. The remainder is mixed with the galena concentrates and is shipped to the St. Joseph Lead Co.'s smelter at Herculaneum for its value as an iron flux.

#### TREATMENT OF SLIMES

The overflow of the deslimers, chat-wheel pits, Caldecott cones and various small settling boxes, is thickened in five Dorr tanks, four of which are 40 by 8 ft., and one 50 by 6 ft. The feed to these tanks averages 2.5 per cent solids, the total flow being approximately 3500 gal. per minute. The solids average 540 tons per 24 hours, or approximately 12 sq. ft. of settling area per ton of dry slime. The central shafts revolves once in 10 min. The overflow from the tanks returns to the

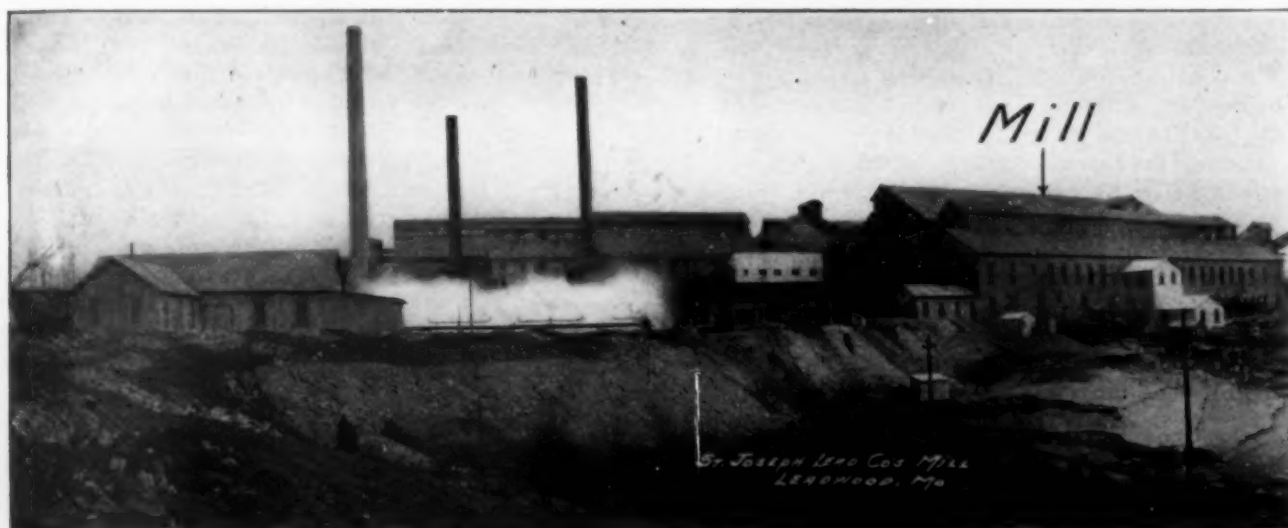


FIG. 8—ST. JOSEPH LEAD CO.'S MILL, LEADWOOD, MO.

mill pond for use as mill wash water, while the spigot discharge is sent to the flotation machine.

The thickened pulp at a ratio of 2.5 to 3.0:1 is treated in a 23-cell Minerals Separation flotation machine, with 24-in. agitating compartments. Creosote oil (hardwood) is added in the feed box and at several alternate cells, a small oil pump being used to give a regular oil feed. The impellers are belt driven from a line shaft, the speed being 335 r.p.m.

The machine is driven by a 100-hp. motor using 83 hp., or an average of 3.8 hp. per cell. The tailings from this machine are retreated in a pneumatic machine. The froth, or concentrates, averaging 50 per cent Pb from both machines, are elevated by a bucket elevator to a Dorr thickener.

Oil consumption averages 0.55 lb. per ton of dry slimes treated. The slimes average 540 tons per day, or, at present, 23 per cent of the ore milled. This percentage is higher than in the other mills of the company, due principally to the use of Cornish rolls and the larger proportion of reground middlings.

#### CONCENTRATES DISPOSAL

The froth is broken up by clear-water sprays and thickened in a 38 by 6-ft. Dorr tank. The overflow goes to the slimes tanks and the spigot discharge, averaging 60 per cent solids, is sent to a 12-ft. by 11-ft. 6-in. Oliver filter. The Dorr-thickener feed averages 90 per cent moisture. A permanent froth remains on the surface and is kept from overflowing by a baffle ring 12 in. inside the overflow and 12 in. above and below the surface of the water. The central shaft revolves twice per hour.

The cake from the Oliver filter averages 15 per cent moisture, and is conveyed by belt conveyor to cars and shipped to the smelter. At present a portion of this cake is dried in vats fitted with steam coils, to a moisture of 7 per cent, in order to enable the smelter to handle the output. The filtrate returns to the slimes thickeners. The filter speed is one revolution in 6 min. and 30 sec. The wet cake averages approximately 50 tons per 24 hours. One "blow" compartment is maintained about 6 in. above the scraper, the other compartment blowing after immersion in the pulp, which is kept at a maximum level. The blow pressure ranges

from 5 to 10 lb. The vacuum is produced by a No. 5 Root pump, averaging 25 to 20 in. The vacuum requires 29.5 hp. and the filter 1.7 hp. The life of a canvas and burlap averages 3 months. After a new canvas is in use from 4 to 6 weeks, steam is exhausted in the pulp for the purpose of heating. This gives a larger capacity without increasing the moisture in the cake. Acid washes have been tried for the canvas without success.

The tailings from the flotation machines are pumped by a 3-in. Morris sand-dredge pump to the impounding pond, against a total head of 50 ft., using 18 hp. The pond dam is built of chat hauled from the mill and is 50 ft. high at its maximum point. The flow of pulp averages 225 gal. per minute, and immediately spreads over the surface of the pond, allowing the solids to settle rapidly. No water remains on the surface, as it filters rapidly through the chat dam. Consequently the pond will eventually fill up in layers, forming a smooth dry body of compact slime. The filtered water is perfectly clear and free from slime.

The mill water is returned to a pond with an area of 17,000 sq. ft., formerly used for settling the mill slimes before the installation of Dorr tanks. Any slimes now escaping the Dorr tanks are caught in this pond and pumped back periodically for retreatment. The volume of water used in the mill circuit is approximately 3500 gal. per minute, or a ratio of 9:1. This compares with a ratio of 17:1 before the change was made in table practice, classification, etc. Loss in mill water, due to waste of flotation tailings, etc., is made up of mine water and from a pumping station on Big River, 3 miles away.

All machinery in the mill is electrically driven, using an average of 7.29 kw. per ton of ore treated. With the present tonnage treated this equals approximately 925 hp. As much machinery as possible is driven by individual motors, even some of the tables using separate 1-hp. motors. All motors are loaded to capacity to obtain greatest efficiency.

The labor in the mill is all American and much more efficient than a few years ago. The tons of ore milled for 1916 averaged 25 per man shift, including maintenance, with an average of 84 men employed per day. Three shifts are operated per day, 6 days a week, Sundays

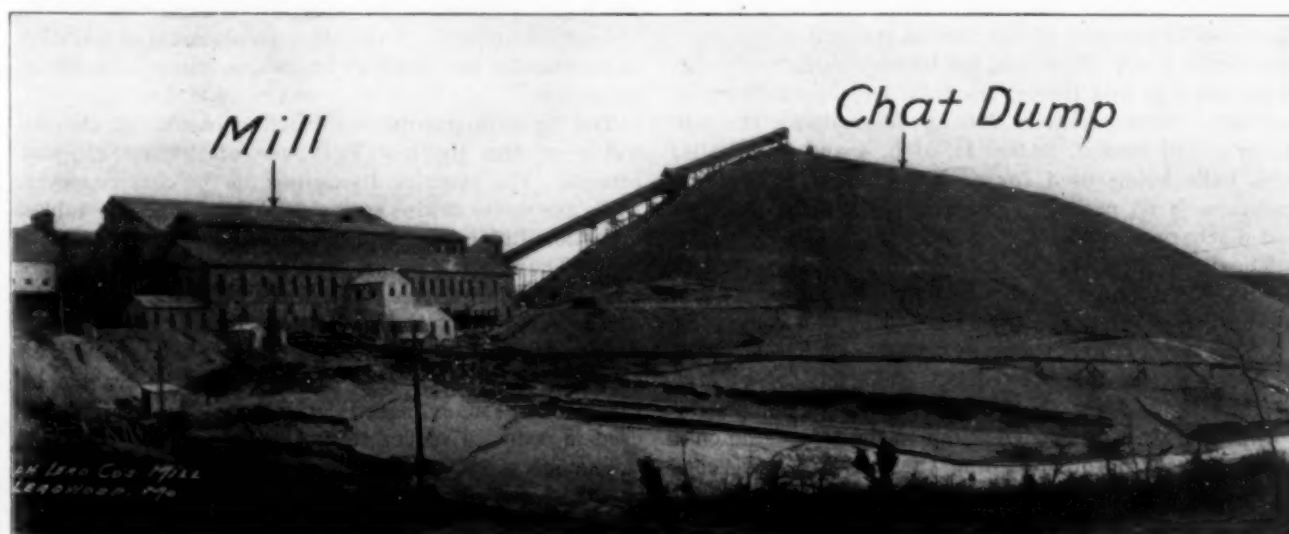


FIG. 8—ST. JOSEPH LEAD CO.'S MILL, LEADWOOD, MO.



being used for repairs. The mill recovery varies with the grade of ore, the tailings from the plant being equal to the district average. Future improvements will probably include larger crushers, substitution of other grinding machinery for the Cornish rolls, and extension of table and flotation equipment, with the view of raising the tonnage, recovery, and the cheapening of costs.

#### THE RIVERMINES MILL

The Rivermines mill is divided into six sections. The ore is crushed to 4 in. at the mine shafts and hauled in A-dump cars by railroad to a large storage bin extending across the mill end. This bin has a capacity of 3500 tons or sufficient for nearly a day's run. A trestle extends beyond the bin, so that the cars may be pinched down grade over the bin and emptied. In winter, steam nozzles are used to thaw the ore sufficiently for unloading. All the ore is weighed on scales on this trestle.

The ore is fed from the bin by roller feeders, operated by a gripping cam, to 1-in. round-hole trommels, 8 ft. long by 24 in. in diameter. The oversize of these trommels is crushed by two No. 3 McCully gyratory crushers, the crusher discharge joining the undersize from the trommels and is carried by belt conveyor to two 48-in. by 12-ft. trommels with 9-mm. round holes. The oversize from these trommels is recrushed by rolls. The discharge from the rolls returns to the conveyor feeding the 9-mm. trommels, the undersize of which goes to an elevator, which raises the dry ore to the 2-mm. trommels on the top floor. From this point the milling practice is practically the same as at the Bonne Terre mill.

#### THE MARCY MILL

An 8 by 6-ft. Marcy ball mill has been installed in section 5 for experimental purposes. This mill has been tried in various tests and is now crushing the oversize from the 9-mm. trommels and the dewatered middlings from the fourth and fifth hutches of the Hancock jig. The discharge from the ball mill goes to the 2-mm. trommels, the oversize feeding the jig and the undersize the tables and flotation plant. As in the Bonne Terre mill, final results have not been worked out on this mill. As it is a grate-type mill, the results are similar to those of the Allis-Chalmers granulator. In this case 73 per cent of the feed to the mill is the oversize of the 9-mm. trommels, the balance being middlings from the jigs and tables, the total averaging 750 tons per day. Approximately 200 hp. is required, the mill using a ball load of 28,000 lb. of 5, 4 and 3-in. balls; 5-in. balls being used for replenishing. The average moisture is 65 per cent. Screen analyses of the feed and discharge product are shown in Table 8.

The jig tailings are dewatered in chat wheels as at Bonne Terre, and the table tailings in sand cones and a sand drag. They are then stacked by belt conveyors, forming a very large tailings pile, which has accumulated since the plant started.

The tailings from the flotation plant are pumped by a 5-in. Morris sand-dredge pump to the top of the chat pile and is used for spreading the chat from the conveyors.

The mill water is settled in a pond back of the plant and is pumped from there to a reservoir situated at a maximum elevation in front of the building, from which

TABLE 8—MARCY MILL RESULTS

FEED				DISCHARGE			
Mesh On	Per Cent, Weight	Cumulative per Cent, Weight	Per Cent Total Pb Content	Mesh On	Per Cent, Weight	Cumulative per Cent, Weight	Per Cent Total Pb Content
1½ in.	27.7	27.7	27.1	3 mm.	20.1	20.1	5.2
9 mm.	41.3	79.0	44.5	2 mm.	9.1	29.2	3.6
3 mm.	14.1	83.1	16.5	20	21.9	51.1	10.0
2 mm.	7.8	90.9	3.4	28	8.4	59.5	6.8
20	4.4	95.3	1.5	35	5.7	65.2	5.5
35	2.0	97.3	1.5	48	5.2	70.4	7.7
65	0.9	98.2	1.2	65	4.0	74.4	6.8
150	0.8	99.0	1.2	100	3.9	78.3	7.7
-150	1.0	100.0	3.1	150	4.0	82.3	9.0
Total...	100.0	.....	100.0	200	3.0	85.3	6.1
				-200	14.7	100.0	31.6
				Total...	100.0	.....	100.0

it is reused in the mill circuits. The volume of water used is approximately 5000 gal. per minute, or a ratio of 7:1 of ore.

All power is alternating current, an average of 8.24 kw. is used per ton of ore treated. The labor is all American. This mill will be rearranged later with ball mills for reducing the general tailings and increasing the capacity.

#### THE LEADWOOD MILL

The Leadwood mill has practically the same milling operations as at the Bonne Terre and Rivermines plants. All the ore is hoisted from No. 12 mine shaft at the mill and is conveyed direct to the crushers. In case the hoist should be out of commission for any reason, the ore from the outlying shafts can be diverted to an ore bin from which it is conveyed to the 5 K Gates crusher, thus preventing an entire shutdown of the mill.

The regular ore feed is screened on a grizzly with bars spaced 8 in. apart. The undersize is crushed in the 5 K crusher and the oversize in the 6 K crusher. The discharge from these crushers is screened through 1½-in. trommels, the oversize being recrushed in three No. 5 D Gates crushers. From here it is conveyed to an ore bin of 1600 tons capacity, and distributed by a tripper on the conveyor.

The ore from the bin is screened through 9-mm. trommels. The oversize is recrushed by rolls and returned to the 9-mm. screens. The undersize is screened through 1½-mm. trommels. From this point the concentration is practically the same as at Bonne Terre and Rivermines.

The jig tailings discharge in the bottom of the tail hutch of the jig and fall over stationary 1½-mm. screens. The oversize discharges on the chat conveyor, while the water drains to the sand drag. Wilfley tables, a portion Butchart riffled, are used for sand concentration. The minus 1½-mm. and plus 150-mesh sands are treated on the coarse tables, the tailings going to a concentrates pit. A drag scraper in this pit dewateres the sands and discharges them on the chat belt with 15 per cent moisture. This drag gives some trouble by breaking, but manganese-steel link chains are now being used in order to reduce this to a minimum.

The fine sands, minus 150-mesh, and slimes are thickened in settlers and concentrated on Wilfley tables, the tailings going to the Dorr tanks at the flotation plant. The overflow of the sand drag also goes to the flotation plant. The slimes are thickened in four 36 by 8-ft.

Dorr thickeners. The pulp is agitated in a 16-cell Minerals Separation flotation machine, the same oil being used as at the other mills. The tailings are re-treated by an air machine, and the concentrates are thickened and filtered by an Oliver filter. The flotation plant is lightly loaded, approximately 350 tons dry slimes, and the concentrates produced average 58 per cent Pb. The slime tailings are pumped to a settling pond behind the chat dump and settle as at Bonne Terre.

The mill chat, jig and table tailings are conveyed by belt conveyor to a tailings pile. This conveyor inclines at an angle of 26 deg. and the chat is sufficiently dry not to cause any slippage on the belt, which is not cupped.

This mill will be equipped with ball mills for regrinding middlings and tailings as at Bonne Terre. A 6 by 4-ft. Allis-Chalmers ball granulator is installed in one section, but has not started operating, so no data can be given. A 3-ft. Hardinge mill is installed for regrinding table middlings as at Bonne Terre, but is just starting operation, and no results are obtainable. The Leadwood ores contain considerable zinc sulphides, which will probably concentrate in this circuit.

The milling practice of the St. Joseph Lead Co. is passing through a transitory stage. Considerable experimental work is being done at each plant, a thoroughly equipped laboratory being maintained at each mill. While large tonnages are being treated in the three plants with the highest recoveries obtainable, it is probable that the introduction of ball mills and further extension of flotation equipment will greatly change the present practice.

Bonne Terre, Mo.

## Motion Pictures at the Exposition

### MONDAY, SEPT. 24

Evening—8.00 p. m.

1. Hydraulic power development (4 reels).
2. Making a giant steam turbine (General Electric Co., 1 reel).
  - (a) Handling pig iron.
  - (b) Filling the cupola and pouring castings.
  - (c) Machining and assembling the castings.
3. Generation of electric power (2 reels).
4. Transmission of electric power (1 reel).
5. The fixation of atmospheric nitrogen by electricity at Niagara Falls and feeding the soil with the products (American Cyanamid Co. 2 reels).
6. The king of the rails, or the evolution of transportation (General Electric Co., 3 reels).

### TUESDAY, SEPT. 25

Afternoon—2 p. m.

1. Carpet weaving (1 reel).
2. Manufacture and use of wool and its products (2 reels).
3. Cotton as a source of wealth—growing and manufacturing its products (3 reels).
4. The manufacture of leather and its products (1 reel).
  - (a) Tanning.
  - (b) Working up leather.
  - (c) Manufacturing of shoes.
5. The manufacture of glass (3 reels).

Evening—

Production of spelter and manufacture of lead prod-

ucts (5 reels and stereopticons showing eighteen months' development).

- (a) Mining zinc and lead ore in Oklahoma.
- (b) Smelting for lead and zinc at Joplin and Henrietta.
- (c) Production of sublimed lead pigment from the ore by the fume process.
- (d) Manufacture of carbonate of lead for paint pigment.
- (e) Manufacture of lead paints, accompanied by descriptive discussion by John R. MacGregor, assistant general sales manager Eagle-Picher Lead Co.

### WEDNESDAY, SEPT. 26

Afternoon—2 p. m.

1. Manufacture of linen bond paper (1 reel).
2. The cordage industry (5 reels).
3. Manufacture of paint (3 reels).
4. The soap industry (1 reel).
5. The manufacture of perfumes "The Spirit of the Flowers" (1 reel).
6. Industrial plants on the Clinchfield Railway.

Evening—

1. The coal, coke and by-products industry (The Barrett Co., 2 reels).
  - (a) Coal mining operations.
  - (b) Old and new methods of coking coal.
  - (c) Recovery of by-products.
  - (d) Use and results from ammonium sulphate as a fertilizer.
2. The asphalt industry (Barber Asphalt Paving Co.).
  - (a) Removing asphalt from Trinidad and Bermudez Lakes.
  - (b) Transportation of raw asphalt.
  - (c) Refining and manufacturing.
  - (d) Building roads and streets.
  - (e) Manufacture of prepared roofings and other products.
3. The petroleum industry—shooting the Lake View Gusher.

### THURSDAY, SEPT. 27

Evening—The metal industries—

1. Copper leaching operations at the plant of the Chile Exploration Co., Chiquimata, Chile. (4 reels).
2. Silver—"The Treasure of the Incas" (2 reels).
3. Gold—"The Basis of Business" (1 reel).

### FRIDAY, SEPT. 28

Afternoon—2 p. m.

1. Asbestos as fire protection (1 reel).
2. Building of roads and their maintenance (DuPont de Nemours Co., 2 reels).
3. Farming with dynamite (DuPont de Nemours Co., 1 reel).

### SATURDAY, SEPT. 29

Afternoon—2 p. m.

1. The manufacture of Portland cement (1 reel).
2. Triumph of the ultramicroscope—seeing invisible colloid particles (1 reel).
3. The milk industry (2 reels).
4. Preparation of condensed milk (3 reels).

Evening—8 p. m.

1. The sugar industry (4 reels).
2. The flour industry (2 reels).

# Bibliography of the Production of Synthetic Nitric Acid and Synthetic Ammonia

By John C. Boyce

## Part I, Literature

	Pub.*	Vol.	Page		Pub.*	Vol.	Page
				<b>1903</b>			
				FRANK, AD.	27	16	536
				The utilization of free atmospheric N for agriculture and industry.			
				HARRER, F.	29	9	381
				Electrochemical engineering in the United States. (The process of the Atmospheric Products Co.)			
				KOWALSKI, J. DE	3 (II)		314
				The production of HNO <sub>3</sub> by electric discharges. Bull. Soc. Intern. Electriciens.			
				Eclairage Electrique	37		505
				LEPEL, F. V.	2	36	1251
				Oxidation of atmospheric N by electrical discharges.	27	1904	1716
					18	22	636
				MUTHMANN, W., and HOFER, K.	2	36	438
				On the combustion of N to nitric oxide in the electric flame.	13	84 (II)	296
				VOLVEY, C. W.	26	3	285
				On the formation of HNO <sub>3</sub> by electric energy.	18	22	780
				Manufacture of HNO <sub>3</sub> .			
				<b>1904</b>			
				EDSTRÖM, J. S.		2	399
				Electrical extraction of N from the air. Electrochem. Ind.			
				FICHTER, FR.	27	17	1181
				The formation of HNO <sub>3</sub> from its elements under the influence of electric discharges.			
				LANDIN, J.	27	18	264
				N cpds. from air.			
				Teknik Tidskrift, 1904, Oct. 22.			
				TRAUBE, W., and BILTZ, AR.	2	37	3130
				The production of nitrites and nitrates by electrolytic oxidation of NH <sub>3</sub> in the presence of cupric hydrate.			
				WIESLER, DR. ARTHUR	27	17	1713
				The utilization of free N.			
				<b>1905</b>			
				BOILEAU, A.	11	47	293
				Utilization of atmospheric N. Electric mfg. of cyanides and nitrates.			
				BRODE, J.			
				Oxidation des Stickstoffs in der Hochspannungsflamme. Habilitationsschrift Karlsruhe, Halle a. S./1905.			
				HARRER, F., and VAN OORST, G.	28	43	111
				On the formation of NH <sub>3</sub> from the elements. (Preliminary communication.)	28	44	341
				KEMPF, R.	2	38	3966
				I. Oxidation by means of silver peroxide. II. The formation of HNO <sub>3</sub> from ammonium sulphate.			
				KEMPF, R.	2	38 (IV)	3972
				Oxidation of NH <sub>3</sub> by means of alkali persulphate in alkaline solution.			
				LAVETH, H. R., and RAND, C. L.	27	18	1906
				Production of HNO <sub>3</sub> from air.	19	3	313
				NEUBURGER, ALB.	27	18	1761
				The utilization of atmospheric N. Gives numerous foot-note references.			1810
							1843
				PERMAN, E. PH.	13	76A	167
				The direct synthesis of NH <sub>3</sub> .	5	91	283
				ROSSI, E.	10	35 (I)	89
				New method of preparing oxides of N and, hence, HNO <sub>3</sub> from compressed air by electric means.	13	88 (II)	386
					29	2	504
				STAVENHAGEN, A.	2	38	2171
				On the oxidation of atmospheric N in the high-tension arc flame.			
				TRAUBE, W.	2	38	828
				Contribution to the knowledge of the electrolytic oxidation of NH <sub>3</sub> .			
				WINTLER, F.	6	29	1278
				Production of HNO <sub>3</sub> from atmospheric N.			
				WITT, PROF. O. N.	6	29	1261
				On the utilization of atmospheric N.	7	28	699
				<b>1906</b>			
				ANONYMOUS		81	89
				Fixation of atmospheric N. Engineering (Lond.).		102	285
				Engineer.		46	297
				Eclairage Electrique.			
				B RTHLOTT, M.	9	142	1367
				Direct synthesis of HNO <sub>3</sub> and nitrates from the elements at the ordinary temperature.			
				BIRKELAND, KR.		2	98
				On the oxidation of atmospheric N in electric arcs. Trans. Faraday Soc.			
				BODENSTEIN, M.	27	19	14
				The production of HNO <sub>3</sub> from air			
				CARLSON, FR.	6	30	1261
				New method for the mfr. of CaCN <sub>2</sub> .	27	21	404
				ERLWEIN, G.		13	137
				On the fixation of atmospheric N and the practical application of the substances obtained. Elektrochemisches Zeitschrift.			161
				On the mfr. of CaCN <sub>2</sub> .	29	12	551
				FUCHER, FR., and BRAHMER, FR.	2	39	940
				The conversion of O into ozone at high temperature and the oxidation of N.			
1786							
CAVANDISH, H.	22	75	372				
Experiments on air.							
1788							
PRIESTLEY, REV. J.	22	78	147				
Experiments on the principle of acidity, the composition of water and phlogiston.							
1861							
PERROT, A.	1	61 (III)	161				
Research on the chemical action of the induction spark of the Ruhmkorff apparatus.							
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Experiments on the electrization of air or O as a means for the production of ozone.							
1874							
CARIUS, L.	2	7	1481				
Oxidation of NH <sub>3</sub> by ozone.							
1875							
BERTHELOT, M.	1	6 (V)	190				
Researches on the O cpds. of N; their stability and mutual transformations.							
1877							
BERTHELOT, M.	9	85	173				
Fixation of N upon organic substances and formation of ozone under the influence of weak electric tensions.							
1880							
SPOTTISWOODE, W.	23	30	173				
On some of the effects produced by an induction coil with a De-Meritens magnetic-electric machine.							
1881							
HAUTEFEUILLE, P., and CHAPPIUS, J.	9	92	80				
On the investigation of gaseous cpds. and the study of some of their properties by means of the spectroscopy.							
1885							
RAMSAY, R., and CUNDALE, J. T.	13	47	187				
The oxides of N.			672				
1887							
RICHARDSON, AR.	13	51	397				
Action of heat on peroxide of N.							
1889							
HOSVAY DE HOSVA	3	2 (III)	360				
Formation of ozone and N acids in combustion.	2	22R	794				
	13	58	447				
VEITH, A.	2	22R	169				
On the combination of N and O in explosions.							
1890							
HEMPFEL, W.	2	23	1455				
Combustions under high pressure.							
1891							
WARREN, H. N.	5	63	290				
A new method for the production of Na and K nitrite.							
1892							
CROOKES, W.	5	65	301				
The flame of burning N.							
1897							
LEPEL, F. VON	2	30	1027				
The oxidation of N by electric sparks and arcs.							
RAYLEIGH, LORD	13	71 (I)	181				
Observations on the oxidation of N gas.							
1899							
BODENSTEIN, M.	30	29	147				
Gas reactions in chemical kinetics. Reaction velocity and "false equilibria."			295				
DIXON, H. B., and PETERKIN, J. D.	14	75	613				
The action of nitric oxide on N peroxide.							
1900							
MACDOUGALL, AR., and HOWLES, FRED.		44	1				
On the production of nitric acid from air by means of the electric flame. Manchester Literary & Philos. Soc., Memoirs.							
SALVADORI, R.	10	30 (II)	389				
Oxidation of N.	6	1901	9				
	13	80 (II)	54				
1902							
ANONYMOUS							
Nitric acid from atmospheric N. A description of Bradley and Lovejoy's process of electrical fixation of atmospheric N in operation at Niagara Falls. Electrician.		49	684				
HEMPFUNE, A. DE	27	1505	1763				
Synthesis of NH <sub>3</sub> from its elements by the electr. spark or by silent electric discharges. Bull. Acad. Royale Belgique.	13	82 (II)	450				
		1902	28				
Preliminary report of the "Cyanid-Gesellschaft m.b.H., Berlin" on its activities in the domain of the mfg. of cyanide and utilisation of atmospheric N for fertilising purposes.	27	16	520				

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<b>1906—Continued</b>							
FISCHER, F., and MARX, H. Thermic formation of osone and nitric oxide in moving gases. On the thermal conditions of formation between osone, N oxide and H peroxide.	2 18 2	39 25 39	2557 808 3631	RUSS, FR. On the combustion of air. Oester. Chem. Ztg.	27 10	21 10	555 237
FÖRSTER, F. What is meant by "activation" of N. On the technical experiments on the combustion of N.	29	12	525 529	<b>1908</b>			
FRANK, A. On the direct utilization of atmospheric N for the production of fertilizers and other chemical cpds.	27	19	835	BECK, E. Preparation of alloys of nitrite-forming metals. (Fixation of atmospheric N.) Metallurgie.	18	27 5	987 504
GRAU, A., and RUSCH, F. Behavior of the electric arc in various gases. Sitz. Ber. Wiener Akademie.	29 13	13 92 (II) 115	345 601 1571	BRINER, E., and METTLER, E. Formation of NH <sub>3</sub> from its elements by the action of electric discharges. Journ. de Chimie physique.	18	27 VI	575 137
GUYE, PROF. PHILIPPE, A. The electrochemical problem of the fixation of N.	18 19	25 4	567 627 136	CRAMP, W., and HOYLE, B. The electric discharge and the production of HNO <sub>2</sub> . Inst. Electr. Engrs., Nov. 3, 1908.	18	28	95
HÄUSSER Production of HNO <sub>3</sub> by means of explosive combustion. Z. Vereins deutscher Ing.	27	1906 50	341 298	DAVIES, J. H. Formation and decomposition of NH <sub>3</sub> by the silent electric discharge in Siemens tube, with special regard to the applicability of the law of mass action.	30 18	64 27	657 1210
JELLINKE, K. On the decomposition velocity of nitric oxide and its dependency on the temperature.	28 13	49 90 (II)	229 437	FRANK, A. Utilization of atmospheric N in the production of CaCN <sub>2</sub> and its use in agriculture and chemistry. Trans. Faraday Society. Chemical industry in relation with agriculture.	18	4 27	99 1093
KAUSCH, DR. O. The infr. of O-N cpds. from atmospheric air by electricity. Elektrochemisches Zeitschr. ft.		13	93	GRAU, A., and RUSCH, F. Validity of the law of mass action for the combustion of N in the high-tension flame. Sitz.-Ber. Wiener Akad. d. Wissenschaften.	29 13	13 92 (II) 117	345 573 758 321
LEMAIRE, F. The utilization of atmospheric N.	11	48	308 328	GUYE, C. E., and BRON, A. Difference of potential and stability of the alternating arc between metals. Difference of potential and stability of the alternating arc struck between metal electrodes. Arch. Sci. Phys. et Natur. The stability of the alternating arc as a function of the atomic weight of the metal electrodes.	9 9	146 25 147	1090 453 e.s. 49
NERNET, W. Equilibrium and reaction velocity in N oxide. On the formation of N oxide at high temperatures.	29 28 29	12 49 12	527 213 257	HABER, FR., and KOENIG, A. Nitric oxide formation in high-tension arcs.	29 18	14 27	630 1070
NEUBURGER The apparatus for the utilization of atmospheric N.	27	19	977	HOLWECH, W. Reactions between nitric oxide and O.	27 18	21 27	2131 1057
ONTWALD, W. On the production of nitric acid from ammonia. Berg. und Hüttenmann Rundschau, Dec. 20, 1906.				JOST, FR. On the NH <sub>3</sub> equilibrium.	28 29	57 14	414 373
SCHMIDT, O., and BÖCKER, R. On the oxidation of NH <sub>3</sub> to nitrous cpds.	2 27	39 1907	1366 283	JURISCH, K. W. Saltpeter und sein Ersatz. Leipzig. Verlag von S. Hirzel, 1908. 356 pages.	29 18	14 27	556 945
TRAUBE, W., and BILTZ, AR. The production of nitrates and nitrites by the electrolytic oxidation of NH <sub>3</sub> in the presence of cupric hydrate.	2	39	166	LOEB, W. Action of the silent electric discharge upon moist N and moist nitric oxide.	29 18	14 27	556 945
<b>1907</b>				MANDL, A., and RUSCH, F. Union of nitric oxide and O.	27 18	21 27	496 333
ANONYMOUS Saltpeter from air. A review.	29	13	75 e.s.	MORDEN, G. W. Formation of nitric oxide from the air by means of a current of electricity of low voltage.	26	14	113
BAKER, H. B., and BAKER, M. Gaseous N trioxide.	13	91	1862	ORLOW, E. Oxidation of NH <sub>3</sub> and organic bases by means of contact substances.	17 18	40 27	650 1150
BREDIG, G. On nitrolim (CaCN <sub>2</sub> ) L.	29 27	13 21	69 158	SCHÖNHERR The oxidation of atmospheric N.	27	21	1633
BRINER, E., and METTLER, E. Influence of pressure on the synthesis of NH <sub>3</sub> in the electric spark.	9 18	144 26	694 416	WOLTERBECK, H. C. Dissociation temperatures of NH <sub>3</sub> and CO. Synthesis of NH <sub>3</sub> by means of peat.	9 9	147 147	400 1400
BRUN, G. The high-tension arc and its significance in the electrochemical industry.	27	20	1685	<b>1909</b>			
BRUNEL, L., and WOOD, P. Synthesis of NH <sub>3</sub> by catalysis.	9 18	145 26	922 1277	ANONYMOUS Hydro-electric N works at Noto-Hen, Norway. Brief outline of the Birkeland-Eyde process of fixing atmospheric N with illustration of the works where the processes are carried out. Engineering. Manufacture of nitrates from air in Germany. Board of Trade Journ. Aug. 19, 1909.	9 18	147 28	400 937
DONATH, E., and FREIER, K. Die technische Ausnutzung des atmosphärischen Stickstoffs. Book published at Vienna by F. Deuticke, 1907.				BERNTSEN, A. Utilization of atmospheric N particularly for the production of air-salt-peter. Seventh Int. Congress Appl. Chem. London, 1909	13	96 (I)	125
FOERSTER, F., and JACOBY, H. On the formation of "nitrolim."	29 18	13 26	101 423	BRINER, E., and DURAND, E. R. Chemical action of the electric discharge at low temperatures. J. Chem. Phys.	13	7 7	1 1
FRANKLAND, PROF. P. F. The utilization of atmospheric N for industrial purposes.	18	26	175	BRINER, E., and WROCZYNSKI, A. Chemical reactions in gases subjected to very high pressures; decomposition of NO and formation of nitrosyl chloride.	9	149	1372
GRAU, A., and RUSCH, F. On the behavior of the electric flame arc in certain gases.	29	13	345	BROCHET, A., and BOITEAU, G. Electrolytic oxidation of NH <sub>3</sub> .	3	5	667
GUYE, PH.-A. The electrochemical problem of the fixation of nitrogen. Moniteur Scientifique.		21	225	BRONNERT, E. Manufacture of synthetic NH <sub>3</sub> . (Serpek's process.) Bull. Soc. Indust. Mulhouse.		79	39
GUYE, C. A., and SERRIKOFF, L. On the difference of potential of the direct-current arc struck between metal electrodes. Arch. Sci. Phys. Natur.	9	145 24	169 549	EYDE, S. Manufacture of nitrates from the atmosphere by the electric arc. Birkeland-Eyde process. J. Soc. Arts.		57	568
HABER, FR., and KOENIG, A. On the formation of N oxide in the high-tension arc.	29 18	13 27	725 27	GUYE, PH.-A. The industrial fixation of N.	3	5 (IV)	1
HABER, F., and LE ROSSIGNOL, R. On the NH <sub>3</sub> equilibrium.	2 29	40 14	2144 181 e.s.	HABER, F., and COATES, J. E. Formation of nitric oxide by the combustion of CO.	30	69	337
LA BLANC, M., and NERANEN, W. The validity of the law of mass action in the combustion of N in the high-voltage flame.	29	13	297	KÜHLING, O., and BERKOLD, O. Action of N on commercial barium carbide.	27 18	22 28	193 423
LEMAIRE, H. Nitric recuperation.	11	52	125	LIPSKI, J. Synthesis of NH <sub>3</sub> from its elements.	29	15	189
NERNET, W. On the NH <sub>3</sub> equilibrium.	29	13	521				
NERANEN, W., and LA BLANC, M. Validity of the law of mass action in the combustion of N in the high-tension arc flame.	29 18	13 26	297 876				
RACHIG, F. New oxides of N.	6 18 27	31 26 1907	359 646 702				

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<b>1909—Continued</b>							
Russ, F. Manufacture of $\text{HNO}_3$ from air in Austria.	29	15	544	MAKOWITZKY, A. Formation of hydrogen peroxide, $\text{HNO}_3$ and $\text{NH}_3$ by the electric discharge with water as one electrode.	29	17	217
WARRBURG, E., and LEITHÄUSER, G. On the analysis of nitrogen oxides by their absorption spectra in the infra-red.	1	28 (IV)	313	SCOTT, E. K. N products with the aid of electric power. Soc. Engrs., Jan., 1911, p. 9.			
<b>1910</b>				TRUTT, R. J. Flame arising from the N burning arc. A chemically active modification of N produced by the electric discharge.	23	85A	533
ANONYMOUS Cyanamide manufacture in France. Times Engng. Suppl., Aug. 17, 1910.				23	86A	56	70
BERTHELOT, D., and GAUDECHON, H. Oxidizing action of ultraviolet rays on gases. Oxidation of oxides of N and of S.	9	150	1517	12	33	1478	
BODENSTEIN The velocity of the combination of nitric oxide with O.	29	16	876	VANDERPOOL, J. A French plant for the fixation of atmospheric N. (Pauling process.) (Transl. from "la Houille Blanche.")	19		196
CARO, N., SCHÜCK, B., and JACOBY, R. Nitrolin (erude $\text{CaCN}_2$ ).	27	23	2405	<b>1912</b>			
HABER, FR., and KOENIG, A. Oxidation of atmospheric N.	29	16	11	ANONYMOUS CaCN <sub>2</sub> production at Niagara Falls. Discussion of American Cyanamide Company's activities, machinery, cost systems used, etc. Oil, Paint & Drug Reporter, July 29, 1912.			
HABER, F. Preparation of $\text{NH}_3$ from N and H. Manufacture of $\text{HNO}_3$ from air.	29	16	244	AUZIES, J. A. A. Technical conversion of N into its cpds. Rev. Gen. Chim. Pure et Appliquées.	18	31	919
HABER, F., and HOLWECH, W. Formation of nitric oxide from air in the arc flame under pressure.	27	23	684		15		233
HABER, F., and HOLWECH, W. Formation of nitric oxide from air in the arc flame under pressure.	29	16	810	BERNTHSEN, H. A. Synthetic $\text{NH}_3$ . Trans. Eighth Intern. Congress Applied Chem., New York.	18	31	982
HABER, F., KOENIG, A., and PLATOU, E. Nitric oxide formation in high-tension arcs.	29	16	780	16	4	760	182
HABER, F., and PLATOU, E. Nitric oxide formation from air by alternating current discharges of very high frequency.	29	16	796	BILLITER, J. Synthesis of $\text{NH}_3$ from its elements. Nernst Festchrift.	18	31	919
HOLWECH, W., and KOENIG, A. Yield of nitric oxide from air in cooled continuous current arcs.	29	16	803	9	155	1149	
HOLWECH, W. The relation of nitric oxide formation to the electrical and thermal properties of short continuous-current arcs with cooled anodes.	29	16	369	BRINER, E. On the limit of formation of so-called "endothermic" compounds at very high temperatures.	9	155	582
LAMY, E. Industrial fixation of atmospheric N. Soc. Ing. Civils de France, Mem., July, 1910.				BRINER, E., and DURAND, E. L. Conditions of formation of nitrous and nitric acids from N oxides and water.	18	31	981
MOSER, A., and ISGARISCHEW, M. Contribution to the knowledge of the chemical action of the silent electrical discharge.	29	16	613	9	155	1495	82
NERNST, W. Specific heat and chemical equilibrium of $\text{NH}_3$ gas.	18	29	1017	18	32	982	
PLATOU, ELIP. A Dissertation, Karlsruhe, 1910, pamphlet 72 pages. Calorimetric investigation into the formation of N oxide from air by means of high-tension alternating current discharge of varying frequencies. (In German.)	29	16	96	DOBBELSTEIN Utilization of coke-oven gas for the production of $\text{HNO}_3$ from atmospheric N. Stahl und Eisen.	32		1571
THOMPSON, M., DEKAY, and LOWBARD, R. H. Equilibrium of the system consisting of $\text{CaC}_2$ , $\text{CaCN}_2$ , C and N.	10	8	324	Utilizing coke oven gases for the recovery of $\text{HNO}_3$ from atmospheric N. Plan and description of Hauser apparatus at Nürnberg. Iron & Coal Trades Rev.	84		1042
WOLOKHTIN, A. Formation of nitric oxide by the combustion of H.	29	16	814	EYDE, SAM Oxidation of atmospheric N and development of resulting industries in Norway. Trans. 8th Inter. Congress of Applied Chem. J. Elec. Power & Gas.	16	4	771
ZENNECK, J. The utilization of atmospheric N by means of the electric flame arc. Physical. Zeitschrift.	19	9	73	28		169	
<b>1911</b>				1912		333	
ANONYMOUS Recovery of N and its uses. Elek. Kraftbetriebe u. Bahnen. Fixation of atmospheric N. Revue Gen. des Sciences.	1911		384	FISCHER, F., and HENE, E. Changes involved in nitric oxide formation in the high-pressure arc.	2	45	3652
BECKMAN, J. W. Fixation of atmospheric N. Elec. Rev. & West. Elect.	1911		908	HAUMER, F. New experiments on the combustion of N in explosive gas mixtures. Z. Vereins Deut. Ing.			
BOURGEREL, G. L. Aluminium Nitride, alumina and $\text{HNO}_3$ . Moniteur Scientifique.	50	533 e.s.		4	6	2295	
CARDELL, T. S., and THOMAS, F. Synthesis of $\text{NH}_3$ by heat.	1911		501	KOCHMAN, W. The catalytic oxidation of $\text{NH}_3$ . Arbeiten aus dem Pharmas. Institut, Berlin.	8		81
EHRLICH, V., and RUSS, F. The oxidation of N by the electric discharge in the presence of ozone. Sitzungsber. Akad. Wissensch. Wien. Monatshefte f. Chemie.	13	27	138	LOWRY, T. M. Oxidation of atmospheric N in presence of ozone.	13	28	64 e.s.
HALLER, M. Report on the presentation of the gold medal to Mr. Ph. A. Guye. Bull. Soc. d'Encouragement à l'Industrie Nationale.	18	102 (II)	41	14	101	1152	
JELLINEK, K. Role of iron as catalyst in $\text{NH}_3$ synthesis under pressure.	114		161	MARRE, FR. Fixation of atmospheric N by means of aluminium nitrides.	11	May 11	1912
KERSHAW, J. B. C. Recent progress in the fixation of atmospheric N. Brief review of the methods in use and types of furnaces, and information concerning the yields and concentrations obtained with the three leading processes. Electr. World.	28	71	121	MENEGHINI, D. Catalytic oxidation of $\text{NH}_3$ .	10	42 (I)	126
LAMY, E. The industrial fixation of atmospheric N.				18	31	383	
LANGMUIR, IRVING Thermal conduction and convection in gases at extremely high temperatures.	19	9	99	NORTON, THOS. H. Utilization of atmospheric N. Dept. of Commerce and Labor, Bureau of Manufactures. Special Agents, Series No. 52, 1912.	8	1912	708
LE BLANC & ESCHMANN The formation and decomposition of $\text{CaCN}_2$ .	20	20	225	REINDERS, W., and CATR, A. Oxidation of $\text{NH}_3$ . Chem. Weekblad.	18	31	280
LEWIS, G. N., and EDGAR, A. The equilibrium between nitric and nitrous acids and nitric oxide.	29	17	20	27	25	586	
	12	33	292	RUSS, F. Oxidation of N and active N.	18	31	383
				SCOTT, E. K. Manufacture of nitrates from the atmosphere. Journ. Roy. Soc. Arts.			
				Repr. Smithsonian Report for 1913, 1914. Publication No.	60		645
				TAUBENT, M. Comparative experiments on the oxidation of N in the high-pressure electric flame arc.	29	18	314
				18	31	498	
				TUCKER, S. A., and READ, H. L. Fixation of N by alumina and carbide.	19	10	745
				18	31	1121	
				<b>1913</b>			
				ANONYMOUS Fixation of N.—Progress in Scandinavia. Times Engng. Suppl. Oct. 15, 1913.	18	32	1008
				The Ostwald process for making $\text{HNO}_3$ from $\text{HN}_3$ . Its proposed combination with the manufacture of $\text{CaCN}_2$ .	19	11	438
				BRINER, E., and BOUNOFF. Chemical reactions in compressed gases: Investigation into the decomposition of $\text{NO}$ .	9	156	228
				Decomposition of nitric oxide at high pressures. J. Chim. Phys.	18	33	21
					11		507

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<b>1913—Continued</b>							
EWAN, TH., and NAPIER, TH. The fixation of N by mixtures of barium oxide and charcoal.	18	32	467	LOWME, E. Ammonification of cyanamide. Zeits. Gährungs physiologie. Bull. Agric. Intell.	18	34	844
FISCHER, F., and HENE, E. Changes involved in nitric oxide formation in the high-pressure arc.	2	46	603	LOWRY, T. M. An oxidizable variety of N. Reprint, Trans. Faraday Soc.	21	28	412
FRAENKEL, W. On the formation of aluminium nitride from alumina, C and N.	29	19	362	MANUELLI, C. Transformation of $\text{CaCN}_2$ into $\text{NH}_3$ . Annali Chim. Appl.	18	33	961
HABER, F., and LE ROSSIGNOL, R. Technical preparation of $\text{NH}_3$ from its elements.	29	19	53	MANUELLI, C. Solubility of the N epds. of nitrolim (crude $\text{CaCN}_2$ ) in water. Annali Chim. Appl.	18	33	189
JELLINEK, DR. KARL. Physikalische Chemie der homogenen und heterogenen Gasreaktionen unter besonderer Berücksichtigung der Stahlschmelzen und Quantenlehre, so wie des Nernst'schen Theorems. Leinsitz, 1913, Verlag von S. Hirzel, pp. 657/61; 682/87; 772/77; 780/87.	18	32	134	MATIGNON, C. Synthesis of $\text{NH}_3$ by means of aluminium nitride.	18	33	690
KÖNG, A. Changes involved in nitric oxide in formation in the high-pressure arc.	19	11	211	MOLDENHAUER, W., and WEHRHEIM, O. Catalytic combustion of $\text{NH}_3$ , $\text{HCN}$ , and $(\text{CN})_2$ .	6	38	894
MENEGHINI, D. Catalytic oxidation of $\text{NH}_3$ II.	2	46	132	OESTERHELD, G. Electrolytic oxidation of $\text{NH}_3$ .	18	33	909
PERKINS, FR. C. Schonherr and Birkeland-Eyde electric nitrate furnaces. Chem. Engr.	18	32	194	SERPEK, O. The inorganic synthesis of $\text{NH}_3$ .	27	27 (I)	829
FRANK, E. J. Cyanamide. Chemical Publications Co., Easton, Pa., 1913, 106 pp.	18	32	238	TIEDE, E., and DOMCKE, E. Active N.	2	47	420
FRANK, E. J. Manufacture and uses of $\text{CaCN}_2$ . (Address before Nashville Soc. of Amer. Chem. Soc., Nov. 15, 1912). Chem. Engr.	18	32	238	ANONYMOUS New method and apparatus for the mfr. of N oxides by the electric method. Patents of methods for the fixation of atmospheric N by arc processes issued in recent years are reviewed in reference. Elektrochemische Zeitschrift.	18	33	254
RICHARDS, J. W. Aluminium nitride. Chem. Engr.	17	113		THE CYANAMIDE WORKS AT NIAGARA FALLS. Reviews the cyanamide industry and gives description in detail of the American Cyanamide Co.'s plant. List of officers given at end. Gives list of European factories and output. Engng. News.	21		211
ROSS, W. H. The decomposition of feldspar and its use in the fixation of atmospheric N.	17	196		ARKENASY, P. Aluminium nitride.	73	16	
RUITJES DE WILDT, J. C. DE, and BERKHOUT, A. D. Cyanamide, dicyanofluoride, and $\text{CaCN}_2$ . Onders. Ryksland-bouproefstat, 1913, No. 13.	16	5	725	BRINER, E. The chemical action of electric discharges. The role of ionization in fixation of N. Jour. Chim. Phys.	27	28	621
RUBS, F. A demonstration experiment on the formation of aluminium nitride.	13	108 (I)	764	CREIGHTON, H. J. M., and GITHENS, J. H. The boiling point of aqueous solutions of $\text{HNO}_3$ at different pressures.	6	39	807
SAPOZHNIKOV, A., GOUDEMA, A., and KOUTOVSKI, E. Influence of various conditions on the oxidation of N in the voltaic arc.	18	34	972	CREIGHTON, H. J. M., and SMITH, H. G. Boiling point of aqueous solutions of $\text{HNO}_3$ at different pressures: II. The influence of water-retaining agents on the compositions of the mixture of maximum boiling-point.	18	35	112
STÄHLER, A., and ELBERT, J. J. Fixation of atmospheric N by means of boron compounds. Reactions at high pressures.	29	19	923	HABER, F. Heat of formation and specific heat of $\text{NH}_3$ . Deutsch. Physikal. Gesells., Nov. 6, 1915.	15	179	161
TIEDE, E., and DOMCKE, E. Active N.	17	45	1076	HABER, F., and GREENWOOD, H. C. Action of uranium as catalyst in the synthesis of $\text{NH}_3$ from its elements.	15	180	703
TUCKER, S. A. The Serpek process for N.	18	32	975	HABER, F., and MARCHEL, A. Investigations on $\text{NH}_3$ . III. $\text{NH}_3$ equilibrium at the ordinary pressure.	6	39	24
<b>1914</b>				HABER, F., and TAMARU, S. Investigations on $\text{NH}_3$ . IV. Determination of the heat of formation of $\text{NH}_3$ at high temperatures.	18	34	278
ANONYMOUS Nitrates and synthesis of $\text{NH}_3$ . Zeit. Vereins Deutscher Ing. Calcium carbide and N products. Engineering (London). Plant for the synthetic manufacture of $\text{NH}_3$ .	2	46	2060	HABER, F., TAMARU, S., and PONNAZ, CH. Investigations on $\text{NH}_3$ . VII. New determination of the $\text{NH}_3$ equilibrium at 30 atmosphere pressures.	29	21	241
ARGO, W. L. Rate of dissociation of N peroxide. J. Phys. Chem.	18	33	4095	KOENIG, A. Electrical activation of N.	13	108 (II)	443
BAKER, H. B., and STRUTT, R. J. The "active" modification of N.	18	33	76	LANDIS, W. S. The fixation of atmospheric N.	18	34	902
CHABRIE, C. Encyclopedie de Science Chimique. Vol. IV. Principes et applications de l'électrochimie par Messrs. Dony-Henault, H. Gall et Ph.-A. Guye. 38 partie: L'acide nitrique synthétique par combustion de l'azote. 1914, Paris. Librairie Polytechnique, Ch. Beranger, pp. 585/672.	2	47	801	SCOTT, E. K. Production of nitrates from air, with special reference to a new electric furnace.	29	21	128
CROSBLEY, A. W. The preparation and commercial uses of H and synthetic $\text{NH}_3$ . Pharm. Soc. Journ.	16	5	191	STRUTT, R. J. A chemically active modification of N produced by the electric discharge.	18	34	1089
DIEFFENBACH, O. Conversion of $\text{NH}_3$ into $\text{HNO}_3$ or ammonium nitrate, from an economic standpoint.	18	33	548	SUMMERS, L. L. Fixation of atmospheric N. Proc. Amer. Inst. Elec. Eng.	23	91	303
HABER, F. On the synthetic production of $\text{NH}_3$ . Modern chemical industry: Synthetic N fixation processes.	7	37	265	WARMBURN, F. S. The cyanamide process. Engng. News.	18	34	422
JONES, B. M. Dissociation of gaseous N trioxide.	18	33	590	ANDERSON, E. B. Catalytic oxidation of $\text{NH}_3$ .	26	27	339
ENOX Fixation of atmospheric N (Book). D. Van Nostrand Co., Publisher, 1914, 110 pp.	27	27 (I)	473	ANONYMOUS N oxides from $\text{NH}_3$ by the Lead-Chamber Process. Engineering (London).	19	12	241
KOENIG, A., and ELBO, E. The after-glow of N. Oxidation of N under the influence of the electric discharge II. Activation of N and O by the direct current arc.	18	33	51	BARTH, S. N oxides from $\text{NH}_3$ and air. Swiss Pat. No. 73377, Sept. 16, 1916.	19	13	309
KOWALSKI, J. DE Phenomena exhibited by highly rarefied N.	18	33	311	HEAVATI, F. Synthesis of $\text{NH}_3$ . Austrian Pat. 72211, Aug. 10, 1916.	73	16	
	9	158	625	HJORTH, A. Synthesis of chemical products (e. g. $\text{NH}_3$ ) by compression of gases. Norwegian Pat. 27386, Oct. 30, 1916.	29	22	441
	18	33	311		4	11	764

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Inventor and Invention	PATENTS						Inventor and Invention	PATENTS					
	Brit.	German	U. S.	French	J. S. C. I.	Others		Brit.	German	U. S.	French	J. S. C. I.	Others
1904													
PAULING, H., Gelsenkirchen Apparatus for the treatment of gases			758, 775				SALPETERFABRIK-INDUSTRIE-GESELLSCHAFT Apparatus for the production of HNO <sub>3</sub> or nitric oxide from atmospheric air by means of the electric arc			186, 454			27-21-558
Process of mfr NO <sub>2</sub> and HNO <sub>3</sub>			758, 774	323, 344	23-545		Method for connecting high-tension flames in series in a high-voltage circuit for the purpose of inducing endothermic gas reactions			193, 366			27-21-558
Process of heating air			777, 485				Electrolytic process for the concentration of HNO <sub>3</sub>			18, 603	368, 716	26-24	
Process of mfr HNO <sub>3</sub>			777, 486				Production of electric arcs for the treatment of air or gases				374, 238	26-795	
Process of making HNO <sub>3</sub> from air	5, 540		814, 917			29-13-380	Process for producing HNO <sub>3</sub> or anhydride from atmospheric air				385, 070	25-928	
							Process for the production of HNO <sub>3</sub> or nitric oxide from atmospheric air			7, 870		25-759	
FATERN, A. J., Alby (Sweden) Method of, and apparatus for, treating gases and gas mixtures by means of voltaic arcs													
			880, 037	349, 227	24-679		SCHERBIS, A. Process for preventing decomposition of the reaction-products in chemical reactions between gases or mixtures of gases			213, 709		28-1198	
			880, 454			27-21-557	SERPEK, O. Mfr of nitrogenized epds of Al for production of NH <sub>3</sub>			888, 044	367, 124	25-1095	
Process and apparatus for carrying out chemical reactions in gases and gas mixtures by means of electric arcs between electrodes (kept a comparatively great distance apart)													
			185, 897			27-21-557	<b>1907</b>						
SALPETERFABRIK-INDUSTRIE-GESELLSCHAFT, Gelsenkirchen Process for the treatment of O <sub>2</sub> containing gas mixtures with the electric flame arc, carbon electrode being used													
			184, 958			27-21-558	BENDER, O., Neu-Babelsberg Process and device for making epds of O (HNO <sub>3</sub> , H <sub>2</sub> SO <sub>4</sub> , etc.) from the elements at a high temperature			8, 653	900, 471	377, 442	27-75
SOC. ANON. D'ETUDES ELECTROCHIMIQUES Apparatus operating with automatic regulation for submitting gases or vapors to the action of the electric arc													
			13, 552	350, 120	24-550		BREDIG, G., and FRÄNKEL, W. Mfr of cyanides, cyanamides and nitriles by means of N and metal carbides			202, 793	382, 188	27-225	
WESTDEUTSCHE THOMASPHOSPHAT-WERKE, G. m. b. H. Electrical process for the mfr of HNO <sub>3</sub> and its epds													
			25, 010			348, 189	24-441	CHEMISCHE FABRIK GRIESHEIM-ELEKTRON Manner of producing Pt contact substances and application to the production of HNO <sub>3</sub> from NH <sub>3</sub> and air			13, 954	380, 884	27-22
<b>1905</b>													
BIRKELAND, K., Christiania Apparatus for producing electric reactions in gases by aid of electric arcs			3, 523			24-895	27-1905-1848	CYANID-GESELLSCHAFT M. B. H. Mfr of N-epds of the alkaline-earth metals by leading N over the corresponding carbides at a high temperature			203, 395		27-1204
HELDIG, D., Rome (Italy) Oxidation of N by means of electricity				587, 326	352, 080	24-896		Mfr of nitrogenous epds by means of carbides				382, 743	27-281
MARGUARDT, E., and VIENTEL, H. Means for producing oxides of N				804, 021				DET NORRKE ARTIFABRIKAR FOR ELEKTROKEMISK IND. and B. F. HALVORSEN Process for the absorption of weak nitrous fumes				380, 190	26-1280
MOCHIEL, J. Device for production of N oxides by means of the alternating-current flame arc						33, 694	29-13-241	ELECTROCHEMISCHE WERKE G. m. b. H. Process for obtaining N peroxide from mixtures of air and nitric oxide, containing only small quantities of the latter			9, 233	199, 561	388, 281
							27-19-960	FERRANTI, S. Z. DE Methods of, and means for, conducting gaseous endothermic reactions (N oxides from air)					27-1058
NAVILLE, A. A., GUYE, C.-E., and GUYE, P.-A. Production of chemical reactions in gases at the temperature of the electric arc						361, 827	26-23	FRANE, A. R., Assignor to Soc. Gen. per la Chim. Amide, Rome (Italy) Process of producing N epds				21, 786	987, 674
Process and arrangement for the production of chemical reactions in gases at the temperature of the arc						361, 827	26-209	Method of producing N epds from carbides					1, 010, 404
Process for carrying out endothermic gas reactions						361, 827		Process for the preparation of HNO <sub>3</sub> from NH <sub>3</sub> by the contact process				5, 314	1, 006, 927
													224, 329
PAULING, H. Production of HNO <sub>3</sub>	7, 874		807, 491				27-19-1104	GEA, P. STICKTODT-UNGER, WESTERHELM Process for the mfr of NH <sub>3</sub> (from cyanamides)			9, 407	922, 003	375, 979
SALPETERFABRIK-INDUSTRIE-GESELLSCHAFT, Gelsenkirchen Process for treating gases with the electric arc, while solid conducting bodies are passed at regular time intervals between stationary electrodes													
						180, 691	27-20-1328	GUYE, P.-A. Preparation of nitrophosphates (recovery of oxides of N from mixtures of the same with air)					389, 864
Apparatus for carrying out the process for the production of HNO <sub>3</sub> or the like from air or other gas mixtures						187, 367							27-1032
								HATCHEL, F., NUNBERG (Germany) Mfr of N oxides			27, 826	218, 518	
SERPEK, O. Process for the mfr of Al-N epds			181, 901				7-1907-158	HELDIG, R., Rome Process for oxidizing atmospheric N by electricity				926, 413	385, 193
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STUART, BAILEY C. Mfr of NaNO <sub>2</sub> and the recovery of by-products in connection therewith						19, 189	25-1044	29-1907-157	MOCHIEL, J., Fribourg (Switzerland) Apparatus for the production of N oxides by electric means				854, 662
													933, 094
THORESEN, J., and THORALDSEN, F. Process for the deviation of arc or electric discharges, and apparatus for the decomposition and combination of gases, for example, of air, by means of these deviated arcs or discharges						13, 689	352, 556	24-976	NAVILLE, A. A., GUYE, P.-A., and GUYE, C.-E. Process and apparatus for the recovery of oxides of N when mixed with air, by means of water				8, 155
									Recovery of oxides of N, when mixed with air or inert gases in the form of conc. HNO <sub>3</sub>				6, 366
WESTDEUTSCHE THOMASPHOSPHAT-WERKE G. m. b. H. Process for the production of epds of N and O by electric means						353, 548	24-1013	NEUBURGER, A., and WESTDEUTSCHE THOMASPHOSPHATWERKE, Berlin Process for producing epds of O and N				9, 939	377, 199
<b>1906</b>													
ARTIFABRIKAR DET NORRKE KVAELTSPARTIFABRIKAR Furnace for treating gases with an electric flame spread out by a magnet to a disc in a small furnace space						179, 825		27-20-1327	NORR HYDRO-ELEKTRISKE KVAELTSPARTIFABRIKAR Process for the absorption of nitrous vapors				206, 949
									PAULING, H. Electric furnaces (Magnetic blower for producing two flame arcs of high tension directed downwards)				18, 901
BORCHERS, W., and BECK, E. Process for the preparation of nitrates from metallic oxides or salts, by means of atmospheric N						196, 323		27-576	Process for connecting in series, arcs of high tension with a high tension circuit				7, 220
									Electric furnaces and process for producing high-tension flame arcs				18, 900
BRINSET, G. J. J., and MIGNET, A. M. Electrochemical process and apparatus for mfr HNO <sub>3</sub> and other epds by means of gases						375, 349	26-930		RAMAT, Sir W. Recovery of oxides of N from air or other gases with which they are mixed				28, 961
									SALPETERFABRIK-INDUSTRIE-GESELLSCHAFT, Gelsenkirchen Process for the production of HNO <sub>3</sub> or nitric oxide from atmospheric air				193, 402
BRUNER, O. H. U. Apparatus for the oxidation of the N of the air for the purpose of obtaining HNO <sub>3</sub>						5, 832	185, 094	834, 257	363, 617	25-846			
Utilization of the N of the air by the oxidation of the same, and conversion of the product into HNO <sub>3</sub> or the salts of HNO <sub>3</sub>						5, 901		363, 618	25-811				
FERRANTI, S. Z. DE, Grindford (Derby) Electric furnaces for the treatment of gases							898, 346		26-1145	27-1908-554			
GORDON, A., and MITCHELL, V. Furnace for the production of oxides of N from air							196, 114		27-576				
LOVEJOY, D. R., Assignor to Atmospheric Products Co. Method of effecting chemical action in gases						829, 872		25-936					
Apparatus for subjecting gases to high-tension discharges						829, 873		25-936					
Method of effecting the combustion of gases						829, 874		25-936					
Apparatus for effecting chemical action in gases						829, 875		25-936					
Process for effecting chemical action in gases						829, 876		25-936					
Apparatus for effecting chemical action in gases						829, 877		25-936					
MITCHELL, J. E., and PARKS, D. Apparatus for subjecting air to electric discharges													
						617, 082							
MOCHIEL, J., Fribourg (Switzerland) Electric plant for producing chemical reactions													
						14, 230		26-876					
Apparatus for the production of oxides of N by electric means						3, 583		369, 387	26-157				
Also Belgian Patent 201,874													
Apparatus for the production of N oxides by electrical process						27, 006		380, 614	27-22				
NORDVER & MARION CO., Indianapolis Catalytic apparatus (mfr of nitric oxide from NH <sub>3</sub> )													
						1, 204	189, 472	362, 434	25-536	29-1907-625			
OSWALD, W. Apparatus for moving and conveying hot N oxides													
						207, 154			29-365				
PAULING, H., Assignor to Salpeterfabrik-Industrie-Geellschaft, Gelsenkirchen Process for the production of HNO <sub>3</sub> or nitric oxide from atmospheric air													
						873, 801	365, 070	25-928					
Process for concentrating HNO <sub>3</sub>						887, 266	368, 716	26-24					
Electric furnaces for treating gases						8, 453		25-1053					
Production of relatively long, strong-current voltaic arcs						7, 869		374, 278	25-935	29-13-228			
Mode of obtaining gaseous endothermic reactions by the aid of voltaic arcs produced in O between fused metallic oxides						19, 800		371, 693	26-117				
Process for producing electric discharges						18, 435		368, 715	26-23				
Production of arcs for the electrical treatment of gases						18, 599		368, 717	26-23	29-13-226			
Electrical production of pure HNO <sub>3</sub> from air						7, 871			25-758	29-13-280			
PLATNER, M. Process for the preparation of oxides of N from gases containing N and O													
						200, 138			27-940				

Inventor and Invention	PATENTS						REFERENCES
	Brit.	German	U. S.	French	J. S. C. L.	v. Note 18	
<b>1908</b>							
COMPAGNIE POUR LA FABRICATION DES COMPTURERS BY MATÉRIEL D'UNES À GAZ Process and apparatus for treating cyanamide to form $\text{NH}_3$ and ammonium sulphate				407,164	29-385		
DARL, O. H. Preparation of oxygenated compounds (nitrogen oxides)				391,822	27-1153		
DIFFENBACH, O., and MOLDENHAUER, W., Darmstadt Process of producing nitric oxides and $\text{HNO}_3$			014,813	389,500	28-365		
ELEKTROCHEMISCHE WERKE G.M.B.H. Process of producing electric discharges of high efficiency. (Fixation of atmospheric N) Process for concentrating oxides of N when mixed with much air				388,112 388,303	27-986 27-939		
ENGELA, O., and DIERRE, F. Process for obtaining conc. $\text{HNO}_3$ from conc. nitrous gases, air and water				229,096		30-84	
GRAT, A., and RICH, F. Process and apparatus for making N oxides from air				884,919 881,920		27-501	
GUYE, P. A. Process of recovery and utilization of oxides of N					404,630	29-211	
HABER, FR., and KOENIG, A. Production of N oxides from air	15,490		638,316	392,670			
LIMP, C. Electric furnace with rotating arc, specially applicable to the nitrification of atmospheric N				403,536			
MOSCHER, L. Process and apparatus for the production of N oxides by means of a rotating electric arc				920,610	395,424	28-529	
NORRE HYDRO-ELEKTRIKE KVALEFÖRTÄRTENSKAB Simultaneous production of $\text{HNO}_3$ and nitrites				388,276	27-897		
OSTWALD, W., Gross-Böthen Catalytic apparatus for transforming $\text{NH}_3$ into oxides of N				7,900	389,050	27-898	
PAULING, H. Assignor to Salpetermindustrie-Gesellschaft, Gelsenkirchen Apparatus for the mfr of $\text{HNO}_3$ or nitric oxide Process for the production of pure $\text{HNO}_3$ Process for mfr $\text{HNO}_3$ by means of superheating				877,446 877,447 882,936	27-160 27-160 27-160		
PICKET, R. P. Process for the preparation of $\text{N}_2\text{O}$ and $\text{NO}$				226,867		29-1236	
POLLACK, E. and G. Mfr of nitrogenous cpds ( $\text{CaCN}_2$ ), utilizing atmospheric N					391,693	27-1167	
ROBERTS, J. L. Method of producing nitric oxide				908,607		27-1152	
SALPETER-SAUERE INDUSTRIE-GESELLSCHAFT Mfr of commercially pure $\text{HNO}_3$ Furnace for treating gases by the electric arc				374,327		Nov. 2, 1908	
STET. MET. C. P. Assignor to General Electric Co. Apparatus for mfr nitrous cpds (electrically)				216,000	406,443	28-1317	
				894,547		27-905	
<b>1909</b>							
ARTERIOLOGISCH SWEDISCHE NITRIC SYNDICATE Process and app. a stat for the continuous expn. of acids, the extraction of $\text{HNO}_3$ by distillation from mixtures containing $\text{H}_2\text{SO}_4$ , etc. Process and apparatus for the concn. of $\text{HNO}_3$				402,078 402,079	28-1197 28-1197		
BADISCHE ANILIN- u. SODA-FABRIK Process of preparing alkali or alkaline-earth cyanides and cyanamides (from nitriles)				200,988 235,662		30-1038	
Mfr of $\text{NH}_3$ from titanium nitride or cyanonitride				2,625		28-309	
Mfr of $\text{NH}_3$				911,468	372,714	26-527	
Mfr of $\text{NH}_3$				30,380	405,712	29-050	
Production of N cpds of Si and their employment for obtaining $\text{NH}_3$				1,202,905	406,943	29-438	
Mfr of $\text{NH}_3$ and apparatus therefor				17,951		29-424	
Process for the conversion of nitriles into nitrites by means of $\text{HNO}_3$				223,028		29-679	
Method for effecting the removal of nitrous acid from solutions containing it				30,503		29-494	
Mfr of nitrates				30,502		29-049	
Absorption of N oxides				10,465		29-423	
Process for the conversion of nitrites into nitrates by means of $\text{HNO}_3$				11,274	220,329	29-065	
Transformation of nitrites into nitrates				231,603	398,736	29-084	
$\text{NO}_2$ free from $\text{HNO}_3$						30-421	
BENDER, O., Potsdam (Germany) Process for the production of oxides of N				18,203	405,463	29-211	
BOSCH, C., and MITTACH, A. Assignors to Badische Anilin- u. Soda Fabrik, Ludwigshafen on Rhine Process of producing cyanides and cyanamides				231,662	1,022,381	30-1035	
Production of cyanide and cyanamide				922,912	387,060		
BUNNET, P., and BADIN, A. Production of cpds containing O and N by electrical means Apparatus for the production of electric arcs intended for the formation of cpds of O and N					402,012	29-1277	Aug. 10, 1909
Production of cpds of O and N by electrical means					406,115	29-1212	June 28, 1909
Production of cpds containing O and N by electrical means					402,012	28-1199	June 26, 1909
Production of cpds containing O and N by electrical means					402,012	29-1212	June 26, 1909
DIFFENBACH, O., and UEBEL, C. Process for the concn. of dilute $\text{HNO}_3$ Electric furnace for gas reactions				338,370		30-1312	
DE FORT, F. L. Assignors to the E. I. du Pont de Nemours Powder Co., Wilmington, Del. Production of oxides of N from the air				943,661		30-32	
DYNAMIT-ART. GEB. FORM. A. NOREL u. CIE Process for obtaining oxides of N from air				228,849		30-86	
GLASER, I., Assignor to General Elec. Co. Process of obtaining $\text{HNO}_3$ from gas mixture containing oxides of N					921,975		28-658
HABER, F. Process for preparing oxides of N by explosive combustion					408,728	29-686	
LE NITROGENE SOC. ANONYME Apparatus for the mfr of oxides of N by means of the electric arc projected in a mixture of O and N Process for preparing $\text{HNO}_3$ of about 65 per cent strength by the absorption in water of oxides of N mixed with a gas containing O					404,230 404,720	29-211 29-211	
NAVILL, A. A., and GUYE, C. E. Self-regulating apparatus for submitting gases and vapors to the action of the electric arc					380,120	29-1117	May 22, 1909
PAULING, H. Improvements relating to the working of electric arcs in series. (Increasing the efficiency of electric flame arcs of high tension in series)					400,745	29-943	
PAULING, H., Gelsenkirchen Method of producing nitrous gases					22,067	30-511	
<b>1910</b>							
SALPETER-INDUSTRIE-GESELLSCHAFT Electric furnaces for the treatment of gases by means of flame arcs					19,166	216,990	29-221
Electric furnaces for the treatment of gases or gas mixtures					8,443		29-718
Preparation of conc. nitrous gases from dilute $\text{HNO}_3$					400,771		29-565
SCHÖRRER, O., and J. BRODE, Assignors to Norsk Hydro-Elektrisk Kvaestof-Aktieselskab Process of making nitration and $\text{HNO}_3$				22,715	1,039,325		29-1167
Process for producing electric arcs					1,003,299		29-1167
SEMPER, O. Process of making Al nitride					15,996		28-1199
Process for making Al-N cpds					15,995		29-25
Process for producing $\text{NH}_3$ from Al nitride					15,997		28-1128
Process for making Al nitride					7,507		29-277
SOC. L'AIR LIQUIDE (SOC. ANON. POUR L'EXPLOITATION DES PROCÉDÉS G. CLAUDE) Process and apparatus for the fixation of N and O at high temperature					1,016,526 987,408		29-1378
SOC. LE NITROGENE Process of recovering nitrous vapors or N oxides diluted by inert gases						421,313	30-543
<b>1910</b>							
BADISCHE ANILIN- u. SODA-FABRIK Process for the production of cpds of Al and N					16,368	1,027,312	30-88
Production of $\text{NH}_3$					17,642	971,501	29-049
Process for the production of voltaic arcs burning permanently					17,643		29-1117
Process for the absorption of nitrous gases					17,644		29-684
Process for discharging the mist which forms in nitrous gases					233,729		30-747
Production of $\text{NH}_3$					1,006,206		30-26
Process of producing $\text{NH}_3$					1,084,194		30-1012
Process for the production of $\text{NH}_3$					19,249		30-45
Process for the production of $\text{NH}_3$ from its elements					19,250		30-45
Production of $\text{NH}_3$ and Al cpds					19,251		30-45
Catalytic mfr of $\text{NH}_3$					15,997		30-26
Process for the production of $\text{NH}_3$					5,382		29-1378
Process of absorbing nitrous gases					20,127		29-1010
BATISCHE STICKSTOFFWERKE ART- u. GEB. Process for the mfr of $\text{NH}_3$ from crude $\text{CaCN}_2$ by means of water and steam					10,441		29-1010
BOSCH, C., and KELLER, H. Assignors to Badische Anilin- u. Soda Fabrik Process of absorbing oxides of N					236,703		29-1010
BOSCH, C., and MITTACH, A. Assignors to Badische Anilin- u. Soda Fabrik Process of producing $\text{NH}_3$ and Al cpds					1,028,526		31-1127
BOSCH, C., and WILD, W. Assignors to Badische Anilin- u. Soda Fabrik Process of making nitrates from nitrites					1,043,799		411,674
BROCHET, A., and G. BOITEAU Process of preparing $\text{NH}_3$ and its derivatives					1,013,964		30-1012
CARLSON, O. F. Process and electric furnace for the continuous preparation of N cpds ( $\text{CaCN}_2$ ) by means of alkaline-earth carbonates and N							417,054
CARO, N. Mfr of $\text{NH}_3$ from N and H					272,638		33-583
COLLETT, E., and ECKHART, M. Process of utilizing the products of decomposition of certain cyanogen cpds					1,005,433		29-1010
DU PONT, F. L. Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. Process for producing oxides of N from the air Apparatus for producing oxides of N from the air					948,372 960,703		Del.
ELEKTROCHEMISCHE WERKE G.M.B.H. Process for the extraction of pure N peroxide from mixtures of nitric oxide and air obtained electrically							411,693
GUYE, P. A., Geneva Process of recovering nitrous vapors or oxides of N diluted in indifferent gases					1,037,052		30-541
Apparatus (electric furnace) for producing endothermic reactions in gases					1,035,581		30-372
HABER, F., Karlsruhe, Germany Mfr of $\text{NH}_3$					999,025		39-1453
HALVORSEN, B. F. Assignor to Norsk Hydro-Elektrisk Kvaestof-Aktieselskab, Christiania Method of absorbing dilute nitrous gases					948,726		29-049
HABER, F. Process of obtaining N oxides by the explosion of gaseous mixtures containing N and O					20,777		30-360
HAYATI, F. Catalytic combustion of N with H or with O Catalytic preparation of $\text{NH}_3$ from its elements					275,663 277,054		33-1009 33-1154
KAISER, K., Wilmersdorf (Germany) Process of oxidizing atmospheric N by means of flame or spark electric discharges					20,323		29-1377
Method of oxidizing N-O cpds					12,224		29-1206
MATTHEWS, A. Assignor to Société Générale des Nitrites Synthetic production of $\text{NH}_3$					984,925		30-1261
NITROGEN, LIMITED Process and apparatus for obtaining oxides of N					1,099,240		30-1211
Process and apparatus for obtaining oxides of N					1,089,241		30-1211
NORRE'S EXPLOSIVES CO., LTD., Glasgow, and D. CAHOE, Stevenson Process and apparatus for producing oxides of N					24,007 9,683		30-1211
NORRE HYDRO-ELEKTRIKE KVALEFÖRTÄRTENSKAB Process for increasing the factor of work (coal) and the stability of electric furnaces							414,925
PAULING, H., Gelsenkirchen Process for conc. aqueous $\text{HNO}_3$ and the like with $\text{H}_2\text{SO}_4$ and other hygroscopic substances					22,320		30-84
Drying of gases or vapors. (Concn. of $\text{HNO}_3$ )					8,533		30-341
Method of conc. aqueous solutions of $\text{HNO}_3$ by means of $\text{H}_2\text{SO}_4$ and other hygroscopic agents					22,323		30-84
PHILLIPS, W. A. Assignor to Nitrogen Ltd., London Method of obtaining oxides of N					1,035,723		31-817
PICKET, R. P. Mfr of nitrous and nitric oxides							415,894
SALPETER-INDUSTRIE-GESELLSCHAFT Process for making pure nitric and nitrous acids by absorption of nitrous gases					9,864		29-1157
Process of producing N oxides from air, or other mixtures of O and N, and apparatus therefor					991,857		30-360
Process for drying gases or vapors (conc. $\text{HNO}_3$ )					991,858		30-541
SCHÖRRER, O., and GUYE, C. E. Process and arrangements for the treatment of gases by the electric furnace, particularly for the mfr of N products							416,726



Inventor and Invention	PATENTS					REFERENCES	Inventor and Invention	PATENTS					REFERENCES
	Brit.	German	U. S.	French	J. S. C. L.			Brit.	German	U. S.	French	J. S. C. L.	
1910							1911						
BERGER, O. Mfr of nitrides Process for the mfr of AlN <sub>3</sub> and other metallic nitrides	13,065			426,856	30-1058		SCHICK, K., Siegen (Germany), and Process of making CaCN <sub>2</sub>			1,008,927	430,000	30-1313	
Process for the mfr of Al nitride Apparatus for the mfr of nitrides such as Al nitride	10,522 12,601		908,032	427,109 430,823	30-421 30-1382		SCHLOSSER, A. T. Process for the absorption of dry and hot nitrous vapors by a base such as lime				441,607	19-923	
Mfr of nitrides such as that of Al Rotary electric furnace, principally for making Al nitride	20,715 20,715		1,044,927 1,030,920	427,066 430,553	30-361 30-1222	June 1, 1910	SHEDDO-LARSEN, A., and SPYRM, O. J. Process for fixing or combining and utilizing N contained in atmospheric air (for production of fertilizers)	12	314	1,031,477	431,182	30-1382	
Electric resistance furnace for making Al nitride Revolving electric furnace with resistances arranged diametrically	20,715 20,299			427,066 430,553	30-1222 30-995	Oct. 28, 1910 Dec. 8, 1910 Aug. 3, 1910	LA NITROGENE SOC. ANON. Process for the preparation of conc. HNO <sub>3</sub> starting with NO <sub>2</sub>			1,031,477	431,182	30-1382	
SHEDDO-LARSEN, A., Assignor to Stern, Bull & Co., Christiansia Process of making N compounds including nitrides and NH <sub>3</sub>				421,313	30-620		SOCIÉTÉ GÉNÉRALE DES NITRURES Mfr of nitrides and NH <sub>3</sub> from N Revolving electric furnace for the mfr of Al nitride			5,795 16,400	438,248	31-641	
SOC. ANON. LE NITROGENE Process of recovery of nitrous vapors such as oxides of N, diluted with indifferent gases				421,022	30-541	Oct. 1, 1910	Process of obtaining nitrides (of B and Al) and NH <sub>3</sub> from mixtures of boric acid and alumina or their op			3,344 <sup>a</sup>	437,168	31-432	
Process of recovering nitrous vapors diluted with mixtures of N and O by cooling							Process of recovering nitrous vapors diluted with mixtures of N and O by cooling						
SOCIÉTÉ GÉNÉRALE DES NITRURES Production of nitrides from N, charcoal and metallic oxides							SHARRER, F., Assignor to the E. I. du Pont de Nemours Powder Co., Wilmington			1,008,383		30-1430	
SÖDERMAN, K. Apparatus for the mfr of HNO <sub>3</sub> Mfr of N <sub>2</sub> O							SHILLERY, J. M. A., Niagara Falls Preparation of nitrodim				982,311		
TIMAR, D. Mfr of N oxides							WASHBURN, F. S., Assignor to American Cyanamide Co., Baltimore				1,004,308 999,071		
TOFANI, G. Process and apparatus for the continuous mfr of crude CaCN <sub>2</sub>							Apparatus for producing CaCN <sub>2</sub>						
WIGOLASKI, F. H. A., and SCHÖNHERR, A. Production of continuous electric arcs and apparatus therefor							WEBER, O. H., and K., Assignors to Chem. Fabrik Griesheim-Electro, Frankfurt				1,042,170	436,201	
1911							1912						
ALST UNITED CARBIDE FACTORIES, LTD. Process for making NH <sub>3</sub> from nitrogen	18,207						ANDRIESEN, H., and SCHEIDEMANDEL, J. Method of carrying out chemical gas reactions by means of an electrical discharge				16,296	31-1093	
BADISCHE ANILIN-UND SODA FABRIK Process for the catalytic production of NH <sub>3</sub> from its elements with help of pure iron as catalytic agent	38,252 <sup>a</sup> 9,841 <sup>a</sup> 31,151						BADISCHE ANILIN-UND SODA FABRIK Process for carrying out operations employing H or gases which contain it				441,695	32-142	
Mfr of NH <sub>3</sub> Preparation of N epds of W Production of voltaic arcs of great dimensions	230,947						Mfr of pure NH <sub>3</sub> Absorption of synthetic NH <sub>3</sub> Mfr of H and N <sub>2</sub> by the interaction of CO and steam under a pressure of 4 to 40 atmospheres at 300 to 600 deg. C. in the presence of a catalyst	35,250 35,260 26,770			438,950 32-909 32-1155		
Catalytic agents for use in mfr of NH <sub>3</sub>	5,835 5,834 5,836						Process for producing NH <sub>3</sub> Method of production of oxides of N by means of electric flame arcs	32,151 <sup>a</sup> 3,345 385,413			425,069	Aug. 10, 1912	
Mfr of NH <sub>3</sub> and catalytic agents for use in the mfr	5,835						Preparation of N epds of Mo from its oxides	250,648 250,649			431,295	32-657	
Mfr of NH <sub>3</sub> Process for preparation of NH <sub>3</sub> Process for producing NH <sub>3</sub> from N epds of Mo Mfr of NH <sub>3</sub>	161 10,772 26,749						Carrying out operations with H under pressure and at a raised temperature Operations in which H is employed under pressure and at high temperatures in iron tubes or vessels Process of producing NH <sub>3</sub> and catalytic agents for use in said process of mfr	28,200 29,200 1,115,628			456,963 32-1000 425,009	32-1000 32-457 31-1125	
COMPAGNIE BORLAISE DES PRODUITS CHIMIQUES Process of fixation of N in form of NH <sub>3</sub> Process of fixation of N in form of O epds	440,217 440,218						Catalytic mfr of NH <sub>3</sub> from its elements Process of production of NH <sub>3</sub> System of absorption of NH <sub>3</sub> Process for carrying out operations employing H or gases containing it	32,352 9,842 35,260 8,617			276,133 1,059,185 431,295	32-233 32-1155 31-1126	
COUATON, G. Synthetic process for mfr of NH <sub>3</sub> Electric furnace for mfr of nitrides Process of mfr of nitrides in the electric furnace Process of mfr of nitrides in the electric furnace Electric furnace for the mfr of nitrides Electric furnace for the mfr of nitrides	436,710 437,789 437,804 437,804 436,789 436,789						Process for the catalytic production of NH <sub>3</sub> from its elements Process for carrying out operations employing H or gases containing it Mfr of NH <sub>3</sub>	1,149,510 1,128,843 3,345			436,261 441,695 441,695	31-721 31-922 31-1031	
DEVANVILLE, L. P. Mfr of NH <sub>3</sub>	2,116						BUCHER, J. E. Fixation of N				1,091,425	455,799	
DYNAMIT AKT.-GES. VORM NOBEL & CO. Production of gaseous reactions in the voltaic arc	3,342 <sup>a</sup>						CENTRALSTELLE FÜR WISSENSCHAFTLICH-TECHNISCHE UNTERSUCHUNGEN Apparatus for working with H or mixtures containing it under pressure and increased temperature, in synthesizing NH <sub>3</sub>				290,877 <sup>a</sup>		
ERCKENROTH, WERKE G.M.B.H. Process for mfr of NH <sub>3</sub> and its epds from oxides of N, such as H <sub>2</sub> N, or as gas or suitable hydro-carbon	5,282						COUATON, G. Process of mfr of nitrides Process and electric furnace for the mfr of Al nitride				457,982 457,982 462,462	32-1010 32-255 33-312	
ELLIS, C. Process for burning N oxides Electrical oxidation of N							DE PONT DE NEMOURS POWDER CO., R. I. Method of obtaining oxides of N from atmospheric air				17,034 <sup>a</sup>	446,269	
FARWATER VORM. MEYER, LUCAS & BRÜNNING Process for making HNO <sub>3</sub> Mfr of HNO <sub>3</sub>	18,328 19,032 15,948						ELEKTROCHEMISCHE WERKE G.M.B.H. Process for the production of pure nitrites by means of nitrous gases containing air or oxygen				10,479	441,706	
HILGER, F. Kaiserlautern (Germany) Process of making nitric oxide and HNO <sub>3</sub>							EPSTEIN, J. Separation of easily condensed or absorbed constituents from hot, compressed gaseous mixture				276,718	33-1154	
HALPERSTEIN, A. Production of gaseous reactions in electric furnaces	26,971						GULINI, G., Como (Italy) Process and apparatus for the production of Al nitride from bauxite or other aluminiferous materials				25,874	451,405	
KAIHER, K. Process of oxidizing atmospheric N (NH <sub>3</sub> by auto-oxidation)	24,033						GEHRMANN, H., Innsbruck Electric furnace for endothermic gas reactions				919	1,035,673	
KOC, C. F. R. VON Method of and means for heating gases to high temperatures for the production of endothermic reactions such as the oxidation of N							GUTE, C. E., Geneva (Switzerland) Stabilizing voltaic arcs				804	1,100,330	
Process for obtaining oxides of N formed in gases at high temperature							HOOFNAGLE, W. J. Electrical treatment of gases and vapors						448,519
LEIBOLM, J. H., Alby (Sweden) Process for producing NH <sub>3</sub> from CaCN <sub>2</sub>	18,207						IRLAND, J. S., Toronto (Can.) Apparatus for forming oxides of N				11,363	1,083,339	
MEYER, E. H., and STOLSEN, J. M. A. Preparation of CaCN <sub>2</sub>							JOHN, L. C., MORTON, D. A., and TANSLEY, G. N., Assignors to Smelt-Solvay Co. Art of oxidizing NH <sub>3</sub>					1,037,261	31-922
MONTAUD, A. DE Catalyst for the oxidation of NH <sub>3</sub>							KUBERN UND COMPAGNIE Process of obtaining NH <sub>3</sub> from its elements using cerium nitride as catalyst				276,986	33-1154	
MÜLLER VON BERNHARD, R., MORBY, N., and GRAP, H., Assignors to Farbwerke vorm. Meister, Lucius, and Brüning, Höchst am Main Process of producing pure nitric oxide	10,523						NARP, E. E., Clydach Mfr of NH <sub>3</sub> and HCN from CaCN <sub>2</sub>				14,412		
NITROGEN LTD. Process and apparatus for obtaining oxides of N	4,268						PAULING, H., Assignor to Falpetersalz-Industrie Gesellschaft, M.B.H. Electric furnace for producing gas reactions				31,478	1,029,888	
NORRE HYDRO-ELEKTRISK KVALEFORSKTELSTATION Process of treating mixtures of nitrites and nitrates for the preparation of pure nitrites and nitrates							Electrode for producing gas reactions by means of the electric arc				1,029,885	31-691	
OSBERT, VERBODEN FÜR CHEM. UND METALL. Mfr of NH <sub>3</sub> from crude CaCN <sub>2</sub> and water							PEACOCK, R. Cpd of Al, C and N Mfr of epds of Al, C and N Cpd of Al, C and N. Process of producing NH <sub>3</sub>				11,305 11,301 11,303	1,035,727 1,031,961 1,031,982	32-363 31-675 31-773
PATLING, H., Assignor to Falpetersalz-Industrie Gesellschaft, Höchst am Main Electric furnace for treating gases Electric furnace Absorption of nitrous gases	8,361 14,122 14,122						PINK, M., Assignor to Dynamit Akt. Ges., Hanburg Method for the preparation of NH <sub>3</sub> from the elements				332,967	1,119,534	
SALFETRIERUNGS-ANSTALT G.M.B.H. Furnace for production of endothermic reactions of gases by means of the electric arc							SCHNEIDER, H. Arrangement for the utilization of heat produced in electric reverberatory furnaces serving for the preparation of O epds of N				431,615	32-601	
							SCHLOSSER, A. T., Paris, Assignor to Norre Hydro-Elektrisk Kvaleforsktation Process for the absorption of nitrous gases or vapors				1,177,350	460,328	
							SCHWEITER, A., and HAUFF, F., Stuttgart Process and apparatus for the mfr of epds of N				3,410	1,067,061	



Inventor and Invention	PATENTS				REFERENCES		Inventor and Invention	PATENTS				REFERENCES	
	Brit.	German	U. S.	French	J. S. C. L.	v. Note 16		Brit.	German	U. S.	French	J. S. C. L.	v. Note 16
<b>1914</b>							<b>1915</b>						
PIER, M., Zehlendorf							THORNTON, C. T., Gothenburg (Sweden)						
Synthetic process for the production of $\text{NH}_3$ from its elements	213		1,137,253		34-670		Production of $\text{NH}_3$ by heating Ba cyanide with water in an autoclave	11,435				34-1207	
Production of $\text{NH}_3$ from its elements	214				34-670		Production of $\text{NH}_3$ by heating Ba cyanide with water in an autoclave	11,450				35-963	
Apparatus for carrying out reactions between H and other gases	9,661				35-538								
Apparatus for carrying out reactions between H and other gases (synthesis of $\text{NH}_3$ )	10,216				35-737		TROVE, E., Assignor to Norsk Hydro-Elektrisk Kvaestofabrik, Christiania						
	10,470						Apparatus for improving the stability of furnaces with magnetically extended electric arcs	1,156,192				34-1182	
<b>SOCIÉTÉ GÉNÉRALE DES NITRURES</b>							<b>1916</b>						
Process of fixing N by means of ferro-aluminium				474,322	35-633	Apr. 21, 1914	BOCH, C., MITTACH, A., and BECK, C.						
Process of fixing atmospheric N				474,365	35-633	Apr. 21, 1914	Oxides of N from $\text{NH}_3$			1,207,708			
Electric furnace for the production of Al nitride				475,908	35-46					1,207,707			
Fixation of N by means of ferro-aluminium				476,121	34-961		CLAMEN, A., Aix-la-Chapelle			1,207,708			
	4,2874						Mfr of $\text{HNO}_3$ or nitram from N oxides			1,178,440		35-633	
TOMMINS, N. C., and UNDER ELECTRIC, DE LA LONRA				476,294	35-46		DOYLE, C. O. A., Notodden, Assignor to Norsk Hydro-Elektrisk Kvaestofabrik, Christiania						
Mfr of $\text{CaCN}_2$ and other N cpds							Electric arc furnace for the treatment of gases			1,194,606		35-1023	
TROVE, E., and EDWIN, E., Assignors to Norsk Hydro-Elektrisk Kvaestofabrik, Christiania				1,122,850	474,194		Electric arc furnace			1,204,349		35-1267	
Electric arc furnace							EDWIN, E., Assignor to Norsk Hydro-Elektrisk Kvaestofabrik, Christiania						
VEREIN CHEM. FABRIKEN IN MANNHEIM							Electric arc furnace			1,193,882		35-971	
Catalytic oxidation of $\text{NH}_3$ to oxides of N				492,567	34-492		ELLIS, E., Montclair (N. J.)						
	12,000						Process of making $\text{NH}_3$			1,184,839		35-737	
WEISS, J., and RIECHER, F., Assignors to R. Kopp & Co., Chem. Fabrik, Oestrich-on-Rhine (Germany)				1,088,139	466,679	33-788	Foss, A., Assignor to Norsk Hydro-Elektrisk Kvaestofabrik, Christiania			1,175,252		35-548	
<b>1915</b>							Method for producing rotating electric arcs						
ALUMINUM-INDUSTRIE AKTIEN-GESELLSCHAFT							GUILIANI, G., Frazzato (Italy)			1,180,840		35-633	
Preparation of Al nitride in electric arc furnaces				465,807	35-1156	Feb. 3, 1915	Process of producing Al nitride						
BADISCHE ANILIN- u. SODA FABRIK							HABER, F., and LE ROSSIGNOL, R.			1,202,995			
Catalytic reactions (synthesis of $\text{NH}_3$ ) and catalytic agents for use therein					35-689		Synthesis of $\text{NH}_3$						
Mfr of N oxides	13,207				35-1108		HANSEN, B.						
Production of oxides of N and catalysts to be employed therein	7,651				35-1015		Receptacle for use in producing $\text{NH}_3$ from $\text{CaCN}_2$ or other chemical			1,203,619		proceeds	
	13,298												
BRADLEY, C. S.							HERSHMAN, P. R., Assignor to Armour Fertilizer Works, Chicago						
Producing chemical action in gases				1,134,883	34-652		Method of producing nitrogenous cpds from Al waste products			1,188,799		35-990	
BECHER, J. E., Assignor to Nitrogen Products Co., Providence (R. I.)							Continuous process of producing nitrogenous cpds of Al						
Method of producing $\text{NH}_3$ and the like				1,138,191	34-661		Production of nitrogenous cpds			1,188,770		35-990	
CENTRALFABRIK FÜR WISSENSCHAFTLICH-TECHNISCHE UNTERSUCHUNGEN, Neubabelsberg							Production of Al nitride			1,188,771		35-990	
Synthetic production of $\text{NH}_3$ from its elements				2,392	35-360		HERSHMAN, P. R., Assignor to The Minerals Products Co., New York						
DE POET, E. I., Wilmington (Delaware)							Production of Al nitride			1,188,651		35-800	
Method of obtaining oxides of N from atmospheric air				1,147,150	34-961		ISLAND, J. S., Toronto (Can.)						
JANE, F. W. DE, Assignor to General Chemical Co., New York							Device for producing oxides of N			1,170,927		35-633	
Production of $\text{NH}_3$				1,141,948	34-799		JENSEN, O., Rjukan, Assignor to Norsk Hydro-Elektrisk Kvaestofabrik, Christiania (Norway)						
Catalyst for the production of $\text{NH}_3$ and process of making							Process of converting nitrous gases into cond. $\text{HNO}_3$			1,197,295		35-1200	
Production of $\text{NH}_3$				1,150,364	34-1249		LABE, H. W.						
Catalyst for the production of $\text{NH}_3$ from N and H, and process of making the same				1,151,537	36-1249		Producing $\text{NH}_3$			1,207,567			
	1,143,396				34-633		LANDIS, W. S., Assignor to the Ammonia Corporation						
LANDIS, W. S., Assignor to American Cyanamide Co., Nashville (Tenn.)							Apparatus for producing $\text{NH}_3$ from $\text{CaCN}_2$			1,183,685		35-737	
Process of producing $\text{NH}_3$ from $\text{CaCN}_2$				1,134,640	34-1207		LANDIS, W. S., Assignor to F. S. Wamburn						
Mfr of $\text{NH}_3$ from $\text{CaCN}_2$				1,149,653	34-661		Method of oxidizing $\text{NH}_3$			1,193,796		35-963	
Process of making $\text{NH}_3$ from $\text{CaCN}_2$				1,163,695	35-115		Process and apparatus for oxidizing $\text{NH}_3$			1,193,797		35-963	
NORSK HYDRO-ELEKTRISK KVAESTOFABRIK, Christiania							Catalyst apparatus for oxidizing $\text{NH}_3$			1,193,798		35-963	
Mfr of nitrous gases				1,200,334	477,726	35-601	Platinum catalyst			1,193,799		35-963	
Process for carrying out gaseous reactions with the aid of air rich in O				480,205	36-215		Catalyst for oxidizing $\text{NH}_3$			1,193,800		35-963	
FRISCO, S., Assignor to International Agricultural Corporation, New York							NORSK HYDRO-ELEKTRISK KVAESTOFABRIK, Christiania						
Electric resistance furnace. Process of making N cpds in electric furnaces				1,129,512	34-865		Process for the mfr of N cpds			10,099		36-214	
	1,129,513						<b>1917</b>						
RANKIN, H. D.							BOCH, C., MITTACH, A., and BECK, C.			1,211,384			
Production of $\text{HNO}_3$				479,492	35-1108		Catalyst for oxidizing $\text{NH}_3$						
SAMUEL, R. A., London							NOTES:						
Treatment of air or gas with an electric arc							<sup>1</sup> Austrian Patent.						
	1,670						<sup>2</sup> Belgian Patent.						
SCOTT, E. K., and HOWLES, V.							<sup>3</sup> First addition, Oct. 11, 1907; second addition, Oct. 12, 1907.						
Electric furnaces for the fixation of N				3,953	35-476		<sup>4</sup> Of the preceding year.						
<b>SOCIÉTÉ GÉNÉRALE DES NITRURES, Paris</b>							<sup>5</sup> Chem. Abstr. V. 11, p. 874.						
Process and apparatus for the mfr of Al nitride							<sup>6</sup> Jour. Gas Lighting and Water Supply, V. 134, p. 236.						
	11,271				478,896	35-115	<sup>7</sup> Chem. Abstr. V. 11, p. 278.						
SUMNER, L. L., Chicago (Ill.)							<sup>8</sup> Chem. Abstr. V. 11, p. 192.						
Method for producing reactions in gaseous at high temperature and apparatus (electric furnaces) for practicing the same				1,125,208	34-336		<sup>9</sup> Chem. Abstr. V. 11, p. 236.						
							<sup>10</sup> Met. Chem. Engng., XV, 1916, p. 539.						
							<sup>11</sup> Chem. Abstr. V. 11, p. 691.						
							<sup>12</sup> Science Abstr. (B), 1917, XX, pp. 56-7.						

### Coal Gas for Automobiles

The present price for motor car gasoline in England is around 60 cents per gallon and this price has given impetus to the search for substitutes. Coal gas has been tried successfully by motor buses, furnishing an acceptable means of obtaining fuel at a considerably reduced cost.

The only change made in the motor is the fitting of a butterfly valve in the air-intake pipe for the regulation of the air supply, which allows the engine to draw the gas in the correct quantity according to load and speed. It is claimed that an advantage accruing from the use of gas as a fuel is that the engine runs cleaner than with ordinary petrol and the valves do not require grinding so often.

In Yorkshire it is reported that the use of coal gas for automobiles appears to be increasing rapidly. Recently Harrogate adopted it, and now Halifax and Tod-

morden have decided to give it a trial. The necessary apparatus is relatively cheap and easily adjusted, consisting of a canvas bag with an inner layer of rubber, shaped like a mattress, which holds the gas drawn from the main, and is strapped to the top of the motor omnibus or to the rear of the automobile. The gas in the bag is connected with the induction pipe, and the engine is worked by the suction process in the same manner as the ordinary gasoline vapor induction.

The principal disadvantage to the use of coal gas for automobiles is the bulky container necessary for the gas. The use of gas for small cars has proved unsatisfactory by reason of the problem of adequate space for storage. A suitable cylinder for containing compressed gas is said to be necessary for the general usage of such fuel for motor cars, and the probability of the continued utilization of coal gas as a substitute for gasoline appears to depend upon facilities for storage or compression.



## The Submarine and Kindred Problems

The thousands of suggestions and plans presented to the Naval Consulting Board for assisting the Government in the present emergency indicate the patriotic fervor of the mass of our citizens.

The board makes a careful examination of every proposal presented. To facilitate this work, by suggesting the elimination of impractical ideas, the board calls to the attention of those who desire to assist it some of the popular misconceptions as to certain fundamental principles which are most frequently misunderstood by the layman.

A careful consideration of the following statements issued by the Naval Consulting Board in their Bulletin No. 1 will greatly simplify the work of that board.

### ELECTROMAGNETS AND MAGNETISM

The electromagnet, the magnetic needle, permanent magnets and magnetism have been carefully studied for many years, and the laws governing their application may be found in any book on the subject.

Although these laws are generally known and applied in a practical manner in a multitude of devices in common use, even the man of wide experience will be astonished at the limited range of practical effect of electromagnets of large size. For instance, the magnets used in our manufacturing plants for lifting heavy masses of iron or steel are designed to exercise maximum magnetic effect, and for operation require a very considerable amount of electrical energy; yet a magnet which can lift 20 tons when placed in contact with an iron plate of that weight, will not lift a 2-in. cube of iron or steel if separated from it a distance of 2 ft. Therefore, proposed devices which depend on the attractive power of magnets for their operation in deflecting or arresting torpedoes, mines or submarines, must be governed by the simple laws of magnetism. A torpedo weighing approximately 2,500 lb., and traveling at a speed of 25 to 45 miles an hour, will not be deflected to any practical degree by any known application of magnetism; and it is not believed that an enemy torpedo, mine or submarine will ever be found in a position to be interfered with effectively by any electromagnetic means, however powerful.

### ELECTRICAL EFFECTS IN GENERAL

There is a general misconception regarding the "electrification" of water and the atmosphere. There is no known method of "charging the sea with electricity," or "shooting a bomb of electricity," or of "charging the atmosphere with electrocuting current." Suggestions along these lines should show evidence that the writer has made research in the laws governing the application of electrical energy, and should contain sufficient proof of their feasibility to insure serious consideration.

On the other hand, applications of the transmission of electrical energy by means of alternating or pulsating currents—as used in wireless systems, for example—belong to a different class of electrical development.

Inventive genius is rapidly improving apparatus of this type for the sending and receiving of signals and messages, and the possibility of valuable results in this field is unlimited.

### PROTECTION AGAINST SUBMARINE ATTACK

This subject, which is occupying the public mind as is no other, divides itself into a number of problems, the most important being the following:

(a) Means of discovering the approach of a hostile submarine and locating it so as to permit of prompt action for combating its attack.

(b) Protection of cargo-carrying ships by nets, guards and screens.

(c) Protection through decreasing the visibility of vessels.

(d) Methods of destroying or blinding a hostile submarine.

Submarines, to operate most effectively, must approach within close range of the vessel which is intended to be torpedoed. The installation of offensive weapons on the merchant marine has increased the necessity for the utmost care being exercised by the submarine commander in remaining unseen by the officers on the vessel to be attacked.

Reports from abroad indicate that in many cases submarines must have remained along certain lanes of travel for periods extending into weeks of waiting, with the expectation of torpedoing certain vessels. Under certain favorable conditions, where the waters are less than 200 ft. in depth, a submarine might lie at rest on the bottom, and if equipped with sensitive listening devices attempt to detect the approach of a vessel. As soon as this evidence was secured the submarine might come to the surface for a quick observation by means of the periscope, and in this manner obtain the proper aim which would be required to register an effective hit.

In case the water is more than 200 ft. in depth a submarine must be kept in motion to obtain steerage way in order to hold its proper depth of submergence. This speed may not exceed 4 or 5 miles per hour, but to remain submerged, and at the same time unobserved, the water must be at least 60 feet deep.

The latest type of submarine which is being used abroad has a surface speed of at least 17 knots per hour and a submerged speed of probably less than 10 knots. The superior gunfire from the merchantman which has been properly equipped would make it necessary for the submarine commander to obtain his observation, such as would permit accurate aiming of the torpedo, during the very brief interval of time required to come to the surface for observation through the periscope, and to again submerge.

If running near the surface, the periscope might be raised, a quick observation taken, and lowered again within 30 seconds. If, however, the submarine is on the surface, and hatches uncovered, from one to four minutes will be required to completely submerge, depending upon circumstances.

A submarine of recent type probably has a total radius of action of as much as 8000 miles when traveling at a moderate cruising speed of from 10 to 11 knots, and may remain away from its home base for as much as one month without requiring either fuel or other supplies during this period.

This type of submarine may have as many as three periscopes, two conning towers, and two rapid-fire guns attached to the upper portion of its hull.

The vessel is steered by very efficient gyroscopic com-

passes, which are unaffected by extraneous magnetic or electrical influences.

A general understanding of the capabilities of the modern submarine for offensive operations will make it easier to appreciate the importance of the three problems which follow:

#### MEANS FOR DISCOVERY

**The Aeroplane.**—When the condition of sea and air are favorable, a submarine is readily discernible from an aeroplane flying at a sufficient height even though the submarine be submerged to a considerable depth.

While aeroplanes have thus been used successfully in the English Channel, they are unable to fly far out to sea where the submarines are now most active. Mother ships for carrying and launching aeroplanes might be used in this connection, but there are only a small number of such ships in operation and the construction of others under present conditions is necessarily a slow process.

Various sound-recording devices, intended to locate surface-vessels, submarines, and even moving torpedoes, are now being carefully tested. Water is an excellent conductor of sound, and the development and improvement of such apparatus offers a promising field for inventive endeavor to those who possess adequate scientific training and laboratory facilities.

Many devices are suggested which depend upon optical means of detection, such as special forms of telescopes and field-glasses to be mounted on ships, or on scouting vessels. Many special forms of searchlights and projectors have been suggested. The fact that a moving torpedo leaves in its wake a stream of air-bubbles caused by the exhaust-air from its propelling engines, offers, under favorable conditions, one means for discovering the approach of a torpedo. This evidence is, however, difficult to detect in a rough sea or at night, and, furthermore, the bubbles do not reach the surface of the water until after the torpedo has traveled onward a distance of from 50 to 200 ft. toward its target.

The dragging of trawls, or nets, by special guard-boats, not only with the view of locating submerged submarines, but also to sweep up floating and stationary mines, is frequently suggested. Under certain conditions this operation is practicable and effective.

It will be seen that each of the above methods, however useful, has its limitations, and scientists and inventors should apply themselves not only to the task of improving these, but also of finding supplementary methods and devices.

#### PROTECTION OF CARGO-CARRYING SHIPS BY NETS OR SCREENS

Many designs of such devices are suggested, and most of them are intended to be attached to the hull of the vessel to be protected. Many other suggestions along these lines, and differing only in some of their minor characteristics from the foregoing, have been received by the Board. Up to the present time not one of these proposals involving screens of any kind has received the approval of the Navy Department or of the Merchant Marine. The principal objections offered to these devices are that they are heavy, difficult to hold in position, unmanageable in a heavy sea, and that they interfere with the speed and with the ability of the

vessel to manoeuvre. The undeniable evidence which has been accumulated during the past few months of submarine activity has demonstrated that the immunity of a vessel to submarine attack is dependent very largely on its speed and also its manoeuvring ability. The percentage of vessels having speeds of 15 knots or more which have suffered from submarine attack is very small, while the losses of slow vessels, whose speed is less than that of a submerged submarine, is practically one hundred per cent of those attacked. Many of the suggested devices would prevent the launching of life-boats or rafts from the vessel to be protected. It is barely possible, however, that there may be developed some form of this general plan which will be found practicable. In no other field have so many suggestions or so many duplicate inventions been presented to the Board.

#### PROTECTION THROUGH INVISIBILITY

The point of lookout on a submarine being close to the water, the position of a vessel at a distance can only be determined by observing its smoke, which floats high in the air. Improved smokeless combustion is therefore desirable. Relative invisibility may also be afforded by methods of painting. Suggestions as to any other methods of reducing the range of visibility will be of interest.

#### DESTRUCTION AND BLINDING OF THE SUBMARINES

A rapid-fire gun is effective when the submarine is seen within accurate range of the gun; but the target is so small that it is difficult to hit.

The powerful effect of any submarine explosion on all neighboring bodies provides a simple means of destroying or crippling an undersea boat. Once it has been even approximately located, the setting-off of a heavy charge of high explosive, well submerged in the vicinity of the submarine, will bring about this result.

In certain areas a quantity of heavy, black petroleum or similar substance which will float on the surface of the water has proved an effective means of clouding the optical glass in the periscope's exposed end.

Under favorable conditions of wind and position, many vessels have saved themselves from torpedo attack by the production of a smoke screen. This may be formed either by incomplete combustion of the oil used for fuel by most naval vessels, or it may be created by burning chemicals, such as phosphorus and coal tar, or mixtures in which these or other materials are used.

After hiding itself from the submarine in a cloud of dense smoke, the vessel, if possessed of sufficient speed, may be able by a quick manoeuvre to change her position and escape before the submarine is able to discharge a torpedo.

#### MINES FOR NAVAL OPERATION

Ever since the first use of gunpowder in the prosecution of war, mines and torpedoes have received great attention both from the warrior and the inventor. Mines are either fixed or floating. The fixed or stationary submarine mine is fired by contact, electricity, timing device or fuse. Such mines, which are extensively used by all navies, are rugged in design and may contain large charges of explosives. They are placed in position by especially equipped mine-laying vessels. Such a mine is provided with an anchoring device.



Floating mines differ from fixed mines in that they are unanchored, and, unless guard boats are at hand to warn friendly vessels of their proximity, may be as dangerous to friend as to foe. Such mines must, according to laws of war, be designed to become inoperative within a few hours after being set adrift.

#### TORPEDOES FOR NAVAL OPERATIONS

The modern submarine torpedo is about 20 in. in diameter and 20 ft. in length; is self-propelled; is not steered by magnetic means, and keeps a fairly accurate course for several thousand yards at an average speed of more than 30 miles an hour. Its weight is approximately a ton and a quarter, and, when traveling at normal speed, possesses great momentum—in fact, in one case, when the high explosive charge in the “warhead” failed properly to detonate, the body of the torpedo penetrated the steel hull of the ship attacked. Torpedoes are also provided with means to more or less effectively cut through screens, nets, or guards placed in their path.

A torpedo is projected from a submarine or other vessel by means of a special form of tube or gun. A small charge of gunpowder or compressed air is employed to start the torpedo, after which—if of the usual self-propelling type—it is driven through the water by its own compressed air motor, the air being supplied from a strongly built reservoir within the body of the torpedo itself. The torpedo is kept upon its course by a gyroscope steering mechanism, which is immune to outside magnetic disturbances.

The detonation of the torpedo is accomplished through a mechanism placed within its warhead, and if the torpedo is either abruptly diverted from its course or is checked in its forward motion the firing device, which is operated by arrested momentum rather than by any form of a projecting firing-pin, instantly ignites the heavy charge of explosive contained within the warhead. The explosion, if it takes place within 20 ft. of the vessel, will usually rupture the ship's plating, because of the terrific blow transmitted through the water from the point of the explosion to the ship's side. The depth at which a torpedo travels may be regulated and is usually between 12 and 15 ft. below the surface.

#### CONFINING THE SUBMARINES

The question as to why submarines are not destroyed before they reach the open sea is a most natural one, and the best answer which it is possible to give according to the officers of our navy and those of the foreign commissions who have visited this country, is as follows:

The submarine bases are very strongly protected by land batteries, aeroplanes and large areas of thickly mined waters extending to such distances that the largest naval gun cannot get within range of the bases. In spite of these protections, there is now going on a continuous attempt on the part of the Allied navies to entrap or otherwise defeat the submarines as they emerge from the protected areas. Nets are laid and as promptly removed by the enemy, whose trawlers are in turn attacked by our destroyers. The design of these nets and the detailed arrangement of their fastenings and attachments offer a broad field for invention, but it should be remembered that they must be capable of being used in waters in which there is a tidal current

running from two to five miles per hour. Many suggestions for “bottling up” these bases have been offered, but, as will be realized, it is not desirable to publish information which would indicate even in the smallest degree this country's plans.

#### SHIPS AND SHIPBUILDING

Many suggestions are made for ships of unusual form to provide for safety in case of a torpedo or mine exploding near or against the hull. Most of these plans are an elaboration of the usual watertight bulkhead construction now required as structural design for all modern ships. The multiplicity of watertight compartments in any hull design tends to add to the vessel's safety. The modern tank steamer used to carry fluid cargoes, such as petroleum products or molasses, is a good example of this design, which has been in general use for many years.

The explosion of a nearby submarine mine or torpedo frequently tears great rents in the ship's plating, in some cases opening a jagged hole 10 ft. or more across, but the destructive effect on the hull of a ship caused by the explosion of a mine or torpedo may be greatly diminished by special hull construction.

From recent experiments and experience it has been demonstrated that the average merchant steamer may be seriously damaged by the explosion of a torpedo 35 ft. away from its hull, but the destructive effect at any given distance from the point of explosion depends to a large extent upon the design and condition of steel framing and plating. A vessel with a strongly built hull can withstand an explosion that would destroy a weaker vessel.

#### INSTRUCTIONS TO THOSE OFFERING SUGGESTIONS

A very large proportion of the letters and plans that are received describe devices or schemes which are obviously impracticable, or which show no novelty or improvement as compared with existing methods. After the elimination of these, the more meritorious inventions are submitted to the various standing committees of the board for examination. If an invention receives the approval of a standing committee, it is presented to the board, with a favorable report, and if then again approved it is forwarded to the Navy Department with the indorsement of the board.

By means of the condensed information contained in bulletins it is hoped that inventors and others who wish to present matters for examination will cooperate with the board by analyzing their own inventions. The board will thus be enabled by this help to spend a larger part of its time in the development of inventions, plans, or devices which are believed to be promising of assistance to the Government in prosecuting the war.

Presumably the Government intends to pay for inventions which it adopts, but as yet no specific provision has been made by law for this purpose.

**Petroleum Marketed in 1915 and 1916.**—The petroleum marketed in the United States in 1915 amounted to 281,104,104 barrels, having an average value of \$0.638 per barrel, according to the Geological Survey. In 1916, 330,899,868 barrels were marketed, having an average value of \$1.10 per barrel. The increase in quantity was 6.99 per cent and the increase in value was 84.38 per cent.



## Henry Marion Howe's Work in the Evolution of Metallography\*

BY DR. ROSSITER W. RAYMOND

The genesis of a new science or branch of science is on this wise:

First, there is the invention of some new means or method of investigation, such as the chemical laboratory, the telescope, the microscope, or the spectro-scope, followed at once by an innumerable host of startling, confusing, mostly qualitative observations. Such an invention reveals to mankind a dazzling but vague new world, the very existence of which was scarcely suspected before, and the indefinite outlines of which inspire poetic generalizations and vast hypotheses; beautiful, if true—beautiful, indeed, irrespective of their truth.

Then comes the long period, less thrilling yet not less meritorious and even more important, during which the means and methods of observation are rendered more precise, and the recognition of differences more minute. At the same time, the older data are revised, corrected and sorted; many, probably most, of them being rejected. This is the stage of preparation of the raw material of the science; and it is characterized in every science by the accumulation of a well-nigh intolerable burden of distinctly separated facts. But this burden must be patiently borne, and the separate units of which it is composed must be delimited, measured and weighed, in order that the mathematical, that is, the quantitative, character may be impressed upon them.

Illustrations of this principle will occur to all who have followed the growth of any science.

General Myer, the creator of our U. S. Weather Bureau, once told me that when he began to organize that service at Washington, he found in the garret of the Smithsonian Institution tons of old papers, containing "weather observations," contributed by public-spirited citizens all over the country, who had heroically got out of bed at certain hours to read their thermometers, rain gages and weather-cocks and anemometers. But nobody had tested or standardized their apparatus, and nobody guaranteed its freedom from accidental aberration or mischievous meddling.

I have heard also of a great German mineralogist who made many thousand measurements of crystals and based upon their varying angles some beautiful hypotheses. But after his death, another mineralogist tested his goniometer, and found in it defects which vitiated his observations.

Such are the pseudo-materials of science, which must be got out of the way before safe induction can begin. But even really scientific data may present, during the stage of verification and inchoate arrangement, an overwhelming complexity which threatens to smother a new science in its cradle. Take, for instance, the condition of biology before Wallace and Darwin. Everybody was furiously busy detecting differences, and founding upon them the definitions of new species, and the mere catalogs of species were beyond the student's comprehensive grasp. We all remember the

universal sigh of relief with which the scientific world, welcoming the Darwinian hypothesis as its new guide, began to study similarities and relationships, instead of differences, and saw the incalculable multitude of individual species group themselves in a grand order, illuminated by a new law.

This emergence of a general formula from a chaos of equations marks the final stage in the genesis of a science. That is not the end, but only the beginning, of its history. It must still grow by accretion, subdivide by fissile separation, and establish its relations to other sciences. And at every step the operations of observation, verification, criticism, analysis and synthesis must be repeated, just as the embryo rehearses in miniature the history of a species.

It follows that the stages of development which I have indicated, though they may seem, on the large scale, to follow one another, really go on, *pari passu*. There is no time at which any one of them ceases. Yet with regard to a single and limited branch of scientific inquiry, their existence and succession may be clearly discerned.

It is my difficult but honorable and welcome task to set before you an outline of the work of a master who has contributed mightily to all these phases in the growth of the new science of metallography: as a discoverer and observer; as an industrious compiler; and as the builder of a noble edifice out of the materials thus gathered and prepared.

Henry Marion Howe was born March 2, 1848, at Boston, Mass. His father was Dr. Samuel G. Howe, famous for his service to Greece in her war for independence (from 1824 to 1830) and later for his labors in the instruction of the blind. His mother was Julia Ward Howe, author of the Battle Hymn of the Republic, and leader in many reforms. It was a good stock on both sides, making him heir to intellectual keenness and refinement, the capacity for both enthusiasm and perseverance, a passion for the pursuit of knowledge, and a gift of clear and felicitous statement.

This inheritance was improved by a liberal education. No matter how vehemently the business or scientific value of a "college course" may be controverted, I notice that, without exception, the successful men who have had such a course are glad they had it, and those who have not, wish they had. We may be sure that Prof. Howe's easy command of his field in technical literature owes much to the circumstance that he was graduated in 1865 from the famous Boston Latin School, and, four years later, received his degree as Bachelor of Arts from Harvard College. Thus equipped, he entered the Massachusetts Institute of Technology, which gave him in 1871 the degree of "Graduate in the Department of Geology and Mining Engineering"—a cumbersome title for which the institution substituted, a few years later, that of "Bachelor of Science." And Harvard made him Master of Arts in 1872, and Doctor of Laws in 1905.

But upon this basis of wide and liberal culture, it was necessary to his future achievements that he should lay another foundation of acquaintance with practice; and this he did during the next dozen years, as a student in the steel works at Troy, manager of works at Pittsburgh, and designer and builder of the works of the Orford Nickel and Copper Co. at Capelton and Eustis in the province of Quebec, and at Bergen

\*An address, very slightly abstracted, made at the presentation of the John Fritz Medal to Professor Henry M. Howe, on May 10, 1917. From the July *Bulletin* of the American Institute of Mining Engineers, which also contains the addresses by Dr. Hollis and Dr. Sauveur and the reply of Dr. Howe, as well as a very interesting list of the many publications by Professor Howe.

Point, New Jersey. His experience in the metallurgy of copper bore legitimate fruit in the publication at a later period of his first book, "Copper Smelting"; but before this appeared (in 1885) he had already become known through his technical papers as an acute observer and reasoner, by no means averse to friendly controversy.

Since it is my present duty to offer, not so much a symmetrical and complete account of Prof. Howe's activities as a description of the particular labors in recognition of which he receives today from his brother engineers the John Fritz gold medal, I shall pass lightly over the general features of his career, merely observing that from 1883 to 1897 he resided at Boston, and, besides his private practice as a consulting metallurgist and expert witness in metallurgical patent suits, was lecturer on metallurgy at the Massachusetts Institute of Technology; that in 1897 he was called to the professorship of metallurgy in Columbia University; from which position he retired in 1913 with the title of Professor Emeritus; and that for the last ten years he has declined as far as practicable all professional business in order to devote himself exclusively to the completion of what had clearly become the great scientific mission of his life. To this end he has maintained at his own expense a special laboratory of research.

It gives me pleasure to fancy, whether or no the fancy be also fact, that I remember the beginning of that mission, forty-odd years ago. In 1871, the first year of the existence of the American Institute of Mining Engineers, Mr. Howe, then just graduated from the Massachusetts Institute of Technology, became a member of the new organization. His two earliest contributions to its Transactions, "Blast-Furnace Economy," in Vol. III, and "Thoughts on the Thermic Curves of Blast-Furnaces," in Vol. V, indicated already that he was making a scientific study of practice. But between the dates of these papers a famous controversy was inaugurated in the forum of the Institute by the brilliant paper of Alexander L. Holley, *primus inter pares*, entitled "What Is Steel?" In this controversy eminent metallurgists like Wedding, chemists like Prime, and expert captains of industry like Metcalf, vigorously took part; but of all the knights of the tourney none rode a straighter course or laid in rest a sharper lance than Howe, whose paper on "The Nomenclature of Iron" ardently advocated a scientific as distinguished from a commercial nomenclature. To tell the truth, the battle had a commercial origin. The real question at issue was not, What is steel? but, What may fairly be called steel at the custom-house? And the technical reputation of the Institute was invoked by one party in favor of a convenient, practical industrial classification which would relieve importers from the expensive refinements of science.

Well, there was even an International Committee on the subject, and the Committee made a Report, and the Report was not adopted by the Institute, except provisionally for optional use in its publications, because the Institute was wisely deemed to be an arena of discussions and not a tribunal of decisions. Never was a more fortunate position assumed, for the great question was left open, as it should be always. The tariff difficulty was adjusted somehow; the antagonists shook hands; the thunder of the captains of industry and the

shoutings died away. But one man continued the inquiry fiercely in his own soul. Henry Marion Howe, before whom the dust of the controversy loomed like a giant Afrite still defying attack, devoted his life thenceforward to the mighty conundrum, What is Steel? That he has spoken the last word—even his own last word—on the subject, no one would venture to say; but certain it is that he has brought us to a degree of knowledge the very existence of which was scarcely dreamed in 1876.

It is curious that at that time he insisted upon the capacity of steel for hardening as an essential element in classification. For it was through this door—the study of the conditions and nature of the hardening process—that the advance was to be made into the wider field of knowledge. And the instrument of knowledge was to be the new science of metallography.

That science, at least so far as it relates to iron and steel, may be said to have begun with the observations of Sorby on the microstructure of iron, reported in 1864 and 1868. Martens published independently in 1878. But already in 1868 Tschernoff had enunciated the chief laws that govern the metallography of iron. These were supplemented by the appearance in *Stahl und Eisen*, 1885, of Brinell's laws. All these creditable steps of progress were rendered more or less uncertain and incomplete by the imperfection of the apparatus and methods of precision, by consequent errors of observation, and by gaps in the data—though the aggregate quantity of material was already overwhelming. Then came, in 1887 and subsequent years, the remarkable investigations and intuitions of Floris Osmond, who discovered that metals frequently combine to form definite chemical compounds, and that these compounds frequently form solid solutions. He discovered also the thermal critical points of iron, and, interpreting these changes in the cooling-curve as indications of some molecular change, propounded the brilliant hypothesis of the allotropy of iron which furnished the acceptable allotropic theory of the hardening of steel. To him, as Prof. Sauveur remarks in his Biographical Notice of Osmond (*Trans.* (1913), 45, 274), we owe likewise the discovery of austenite, the non-magnetic solid solution of iron and carbon existing above the thermal critical range, and the transition-constituents, martensite, troostite and sorbite, marking as many distinct and important steps in the transformation, on cooling, of the solid solution austenite into the ferrite-cementite aggregate.

This brings us to the date of Howe's first book on the subject; and the history of the new science, as I have already sketched it in general terms, is epitomized in the essays and books of Prof. Howe from the appearance of his "Metallurgy of Steel" in 1888 to that of his "Metallography of Steel and Cast Iron" in 1916. The first of these books was an amazing accumulation of reported facts, tabulated, verified and explained as far as was then practicable. The last is an equally amazing array of facts, but now sifted, tested, logically arranged and luminously interpreted, exhibiting not uncomprehended differences, but significant similarities and relationships. The first was a heap, parts of which had been sorted; the last is an edifice. To produce the first required intelligent and inexhaustible industry and critical discernment. The second exhibits the creative genius of an architect. Between the two lies the history



of a science, to every stage of which this builder has made some important contribution. Let me mention a few of these, under the heads of invention of improved methods; discovery of new facts; testing of data; and correlation and interpretation of observed phenomena. I shall not pretend to comprehensive completeness in this survey. I must be content with the exhibition of typical samples.

One of the new methods invented by Prof. Howe is that of determining the microstructural and other conditions which exist in steel at high temperatures by fixing those conditions through the process of quenching—a method which has been generally adopted, and by the use of which much clearer and more trustworthy results have been obtained than were formerly possible.

Among his discoveries of new facts may be mentioned the isotropy of the effects of plastic deformation (announced in 1888, and supported in 1914); the possibility of effacing blowholes in soft steel by welding (1909); the relations of graphite flakes in cast-iron, representing, not complete discontinuities of the metal, but only the filling by graphite of the interstices in ferrite skeletons; and the crystallography of the slip planes ("Metallography of Steel and Cast Iron," 327).

But this investigator kept himself acquainted with the discoveries of others. In 1893 he confirmed by rigorous experimental proof the brilliant hypothesis of Osmond that the transformations in steel represent the alternate acquisition and loss of hardening capacity.

Under the head of testing and verifying data I would name the rigorous analysis of the so-called Clapp-Griffiths process; the demonstration that the chief benefit of rolling and forging is due to the low finishing temperature rather than to the degree of mechanical reduction, as formerly believed; and the striking demonstration that the results of one of the most important investigators of the gas evolved from iron were wholly vitiated by the leakage of the apparatus. All these may be found in the "Metallurgy of Steel," which contains also analyses of the conditions of dephosphorization; of the chemistry of the crucible process, and of the technique of Bessemer practice.

In a remarkable paper on the structure of steel, contributed to the proceedings of the American Society for Testing Materials for 1911, Prof. Howe collected into the form of propositions or laws the observed relations of heat treatment to the microstructure and mechanical properties of steel. In that paper he enunciated twenty-three of these laws; and had he then ceased from his labors, his work would have followed him as an imperishable record indelibly carved upon the history of science. But he was destined to go still further during the five years which followed. His latest book, "The Metallography of Steel and Cast Iron," published in 1916, occupies intellectually a higher plane than its predecessors, by which I mean that it commands a wider outlook, permitting grander generalizations, and the recognition, in due perspective, of causes, effects and relations. This book, in short, exhibits that simplification which I have described as following the stage of maximum complexity in the development of a science. Its very title, coupling steel with cast iron, expresses the maturer view which includes both in one continuous series, subject to the same laws—a significant conclusion of the controversy which began with the contention that steel was not cast iron. Not that

the difference has been disproved, but that a higher unity has been shown to embrace it. Such is indeed the normal end of controversy—"peace without victory" through agreement on a higher level.

This book is not a text-book, repeating what is generally accepted already. Covering the field in which others have meritoriously labored, it propounds, suggests and prophesies new truth and new views of truth. It is a product of the two kinds of genius, the genius which consists in an infinite capacity for taking pains, and the genius which with happy intuition surveys, divines, coordinates and interprets the cosmos in the chaos.

That my estimate of the work of our great American colleague, as summed up and set forth in this book, is not merely an expression of personal affection or patriotic pride, let me prove by one or two opinions from eminent authorities.

I would quote first a few paragraphs translated from a review of the book by Prof. Le Chatelier in the *Revue de Metallurgie* (Vol. 13, No. 2, March-April, 1916):

"The new work of Mr. Howe is entirely original. It has nothing in common with the numerous treatises on metallography which have appeared during the last ten years. Whoever has read one of them has read them all. Here we have to do with the personal observations and views of the author. As he indicates in his preface, he has written this treatise, not to state the solidly established principles of a young science, but to cause the creators of that science themselves to think; to open before them new horizons. Hence he has not feared to announce theories sometimes a little hazardous. . . .

"This study will make an epoch in the history of the progress of science. It represents many years of uninterrupted research, but for a much longer period it will certainly be consulted by investigators with fruitful results."

The following remarks are taken from a similar review by H. C. H. Carpenter, Professor of Metallurgy at the Royal School of Mines, South Kensington, England.

"It is quite safe to say that Prof. Howe's book will at once take its place as an authoritative, and, indeed, classical, exposition of the field of knowledge with which it deals. From whatever standpoint it is judged, it is a great book—great in its power, lucidity, balance, comprehensiveness, and pre-eminently scientific character."

In a private letter, written with reference to the announcement that the John Fritz medal was to be conferred upon Prof. Howe, the same distinguished author says that he believes no award could have given greater pleasure to the metallurgists of Great Britain, who look upon Prof. Howe, not merely as the *doyen* of metallographists in America but as their most distinguished representative; "a worker whose single-mindedness in the pursuit of truth is an example to us all, and whose conscientiousness gives to his publications a character of their own."

Finally, I take the liberty of quoting from a private letter received by me from a no less eminent American, Prof. Albert Sauveur himself, who, as the President of the Board of Award, bestows this medal to-night:

"Prof. Howe, in his recent masterly book on the metallography of steel and cast iron, reviews exhaustively and examines critically, as he alone can do, every



view at all worthy of recognition, dealing with the subject he covers. I believe that any responsible author who has ever expressed a reasonable opinion on any subject dealing with the metallography of iron and steel will find his views recorded and discussed in this book. Prof. Howe then proceeds to weigh with great fairness and extraordinary intelligence and lucidity the arguments or evidence supporting the different views, and draws his conclusions accordingly. His method is that of a mathematician solving a problem in which each factor is given its proper value. In this way Howe has rendered to metallurgists an inestimable service; and he alone could render it. Where most of us could see only chaos and obscurity, he is able to bring order, and to discover the light that, under his skillful manipulation, soon illuminates the darkest corners. . . .

"This, I think, is his greatest achievement—the marvellous coordination which he has brought into the science of metallography through his genius and his labor, tremendous in quantity, marvellous in lucidity. To him more than to any one else we owe the quick rejection of weak or ill-supported theories, in favor of the survival of the fittest—a process so necessary to the advance of any branch of human knowledge."

To these expressions of individual and representative opinion should be added the numerous formal honors bestowed upon Prof. Howe by institutions and governments in many lands. England, France and Russia have each conferred three of these recognitions, while others have come from Germany and Sweden. And, last but by no means least to his patriotic heart, come two announcements, received since I began the preparation of this address: the one, of his election as a member of our National Academy of Science; the other, of his selection as one of the charter members enumerated in the proposed Act of Congress incorporating the American Academy of Engineers.

Thus the applause of two continents attends the act of the John Fritz Medal Committee in selecting Henry Marion Howe as a recipient of that great honor. And the act has also another significance. It is a recognition on the part of engineers that the microscope and the test-tube have become the tools of engineering. Indeed, when we remember that the strength of materials is the alphabet of every branch of engineering science represented by the givers of this medal, we must admit that the man who with microscope and test-tube analyzes the causes and determines the conditions of that strength is among the greatest of engineers.

While this testimonial is bestowed by engineers, I cannot forbear to utter my satisfaction that it is received by one who is more even than an engineer; whose many-sided patriotic and literary activity is typical of this age, in which engineers are, as St. Paul said of the Gentiles, "no more strangers and foreigners, but fellow-citizens with the saints." If we may say of him, as Johnson said of Goldsmith, "*non tetigit quod non adornavit*," we may almost add, "*non est, quod non tetigit*." And so we crown to-day with grateful pride, not only the leader, but also the comrade and friend!

A committee from the House of Representatives headed by Congressman Dent of Alabama has been appointed to investigate the circumstances surrounding the recent shipments of defective ammunition to American forces in France.

### Italy Fixes Maximum Prices of Coke

The "Gazzetta Ufficiale," published at Rome, July 30, 1917, contains a decree of the Minister of Industry, Commerce and Labor concerning the maximum selling price for gas coke, according to a recent number of "Commerce Reports," and which should be interesting to coke makers and consumers, in the light of recent American Developments.

From Aug. 1 to Sept. 30, 1917, the maximum selling price of gas coke for immediate delivery or C. O. D. at factory is fixed as follows: (a) Coke, large, 280 lire (\$54.04) per ton; (b) powdered, with mesh, 293.50 lire (\$56.65); (c) nut coke, 152 lire (\$29.34); (d) coke, bulk cargoes without mesh, 255 lire (\$49.21).

The communes are to fix a moderate superprice for the sale and delivery of these goods ex-factory in their territory.

Persons selling gas coke at prices higher than those established, plus any communal superprice that may be fixed, will be fined 200 or 300 per cent of the entire price received from such illegal sales. Repeated offense will render the offender liable to one year's imprisonment in addition.

In case a dealer, producer, or any other seller refuses to sell gas coke at the established maximum prices, plus the communal superprice, the prefect, or if necessary the syndic, may sequester the goods and cause them to be sold at the expense of the holder, for whom, however, the amount necessary for his own consumption will be reserved.

### Australia's Restrictions on Tin Plate

The Minister for Defense prohibits (unless the written consent of the director of munitions has first been obtained) the use of tin plates for the manufacture of containers or the tops and bottoms of cardboard containers for the following goods: tobacco and cigarettes; boot polish; confectionery, except boiled sweets; powders of all descriptions; soaps, except liquid soap; spices; dry pharmaceutical preparations; linoleum polishes, and metal polishes; or for the manufacture of the following goods: Crown seals; bird cages; toys; advertising boards and signs; fancy canisters, and letter boxes.

This order does not apply to tins already manufactured, but holders of stocks of tins used for containers as specified were required to render immediately to the director of munitions a return showing the quantity of each class of tin on hand at the date of the order and their average monthly consumption of each class of tin, such return to be verified by statutory declaration.

Any person who uses tin plate in contravention of the order is declared to be guilty of an offense against the war precautions act, and is liable to punishment by a fine not exceeding £100 or imprisonment for a term not exceeding six months, or both.

In the case of dry foodstuffs for export, military, or Red Cross purposes, favorable consideration will be given by the director of munitions for applications for exemption from the requirements of the order, but the position regarding stocks of tin plates is such that even with regard to these requirements every endeavor must be made to make cardboard or other similar containers suffice.

## The Synthesis of Ammonia and the Oxidation of Ammonia to Nitric Acid\*

By Edward B. Maxted, Ph. D., B.Sc.

The direct production of ammonia from its elements is at the present time a subject of peculiar interest, not only by reason of the conditions under which the reaction is carried out in practice, but also because it constitutes the most economical method available, if the initial difficulties are once overcome, of fixing atmospheric nitrogen.

It has long been known that on leading a mixture of nitrogen and hydrogen over certain catalysts, such, for instance, as iron or manganese, small traces of ammonia are produced even at atmospheric pressure, while in conformity with the well-known principle of Le Chatelier, the equilibrium ammonia-content for a given temperature is increased by carrying out the reaction at an elevated pressure, the use of a pressure furnace for the synthesis of ammonia having been described, for instance, by Jost early in 1908.

We are, however, almost exclusively indebted to the pioneer work of Haber for the discovery of catalysts which become active at comparatively low temperatures and therefore under conditions such that the ammonia content of the reaction mixture is raised to values sufficiently high to render possible the commercial utilization of the synthesis, while the subsequent development of his methods by the Badische Anilin und Soda Fabrik constitutes a most remarkable example of the introduction of modern physico-chemical methods into commercial life.

Despite the fact that no less than about 1,000,000 tons of synthetic ammonium sulphate per annum is being manufactured by the Badische Anilin und Soda Fabrik in Oppau near Ludwigshafen, the published information regarding the process is extremely scanty. For this reason it may perhaps be of interest to give some description of the work undertaken and results obtained by my own company towards the establishment of a technically sound foundation for a synthetic ammonia industry in Great Britain.

The first step in the industrial synthesis consists in the choice and adoption of suitable methods for the manufacture of nitrogen and hydrogen. The formation of ammonia is extremely sensitive to the presence of even minute traces of inhibitive substances, and it is therefore absolutely essential for the success of the reaction that these component gases be obtained not only as economically as possible, but also in a state of practically absolute purity, and above all free from catalyst poisons of every nature. While methods exist for the direct production of a nitrogen-hydrogen mixture, these in general tend to give a gas containing an appreciable quantity of catalytically poisonous carbon monoxide, and for this reason we find that it is not only simpler, but also more satisfactory from an economic standpoint to manufacture our gases separately and to mix them in the proper proportions as and when required.

The most economical method for the manufacture of pure nitrogen is undoubtedly that of low temperature separation from air. We utilize for this purpose the

Pictet process, according to which air, cooled by exchange and by other means down to, but not below, its liquefying point, is injected, in the gaseous condition and at a pressure approximately equal to atmospheric, into a separating column (see Fig. 1) over the plates of which a descending current of liquid nitrogen is allowed to flow. This liquid nitrogen exerts an analyzing influence on the air to be separated, in that it permits the passage upwards, as a gas, of the nitrogen of the air, while atmospheric oxygen is condensed by the current of liquid nitrogen and flows as a liquid nitrogen-oxygen mixture into the lower part of the column, where it undergoes continuous fractionation in such a way that it reaches the reservoir at the bottom of the separating column as liquid oxygen practically free from nitrogen. It will thus be seen that, in the process which we employ, only one-fifth of the air to be separated is liquefied, the nitrogen being kept in a gaseous condition during the separation and only a small fraction being subsequently liquefied in order to maintain the flow of liquid nitrogen, necessary for separation, over the plates of the column.

This subsequent liquefaction of a small proportion of the nitrogen produced is carried out in two ways, namely, in the first place by slight compression in closed coils contained in the oxygen reservoir and on the plates of the column, a suitable pressure for liquefaction being obtained by the use of a small compressing system, of such a nature that the pressure in the various coils can be adjusted to correspond with the temperature obtaining in the particular portion of the column in which the coil in question is situated. Thus

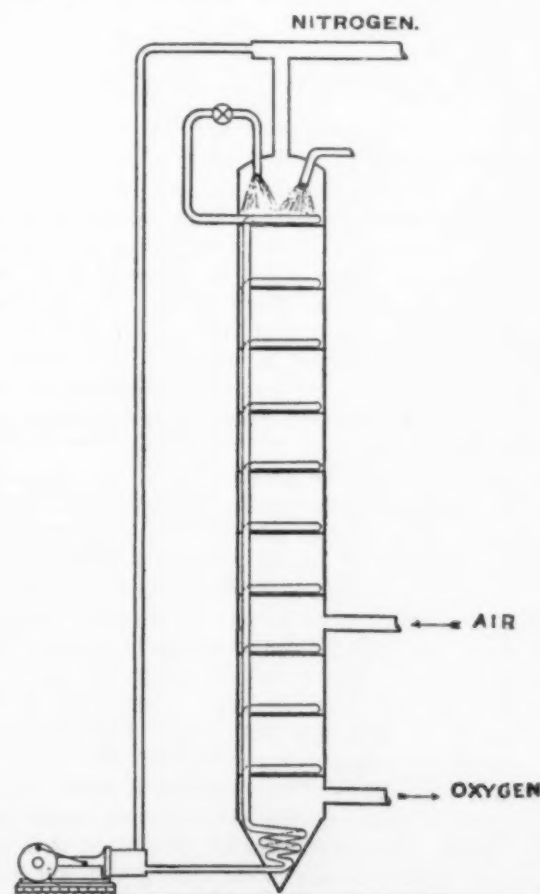


FIG. 1—PICTET PROCESS FOR NITROGEN

\*A paper presented at the annual meeting of the Society of Chemical Industry in England and published in the Journal of the Society, July 31, 1917.

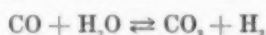
a coil at the top of the column where the temperature is  $-196^{\circ}\text{C}$ . would require only a very slightly increased pressure to induce liquefaction of the nitrogen contained therein, while a coil in the oxygen reservoir at the bottom of the column, at a temperature of  $-182^{\circ}\text{C}$ . must be supplied with nitrogen at a pressure of several atmospheres, the latent heat of liquefaction in the coils supplying the heat by means of which the mixture on the lower plates of the column is fractionated.

Losses of cold due to radiation and imperfections of exchange are compensated by the liquefaction by expansion of a further quantity of nitrogen, this forming the second source of the separating liquid referred to above.

The system described has been installed on a scale giving 400 cubic meters of nitrogen and 100 cubic meters of oxygen per hour and has proved extremely satisfactory both from the point of view of the purity of the gases produced and by reason of the abnormally low power required for operation as compared with other systems.

Passing from the manufacture of nitrogen to that of hydrogen, it will be seen as the result of even superficial calculation that the cost and purity of hydrogen constitute the key to an economical synthesis of ammonia.

Rejecting electrolytic hydrogen on account of its high cost, there exist various methods of preparing hydrogen in a more or less pure condition from water gas. By the so-called continuous method, water gas and steam are passed together over a catalyst, consisting usually of activated iron oxide, when by the interaction of the carbon monoxide of the water gas with the steam, the carbon monoxide is replaced by an equal volume of hydrogen according to the equation:



The carbon dioxide thus produced is absorbed by compression on water, hydrogen sulphide and other impurities being removed by iron oxide purifiers of the usual type. It is found in practice, however, that the above reaction is never complete, however great the excess of steam, and that the hydrogen produced contains considerable quantities of carbon monoxide, which is of course not absorbed by the ordinary purifiers. This may be eliminated by treatment with calcium carbide, or by compression on heated soda lime with the formation of formates.

The same objectionable presence of carbon monoxide occurs in hydrogen prepared by the low temperature separation of water gas, by reason of the very appreciable vapor pressure of carbon monoxide even at temperatures approaching its solidifying point.

Carbon monoxide is also found in hydrogen manufactured from water gas by the intermittent process, i.e., by the alternate steaming and reduction of iron. It occurs in this method of hydrogen production owing to the instability of carbon monoxide at high temperatures, which decomposes according to the equation  $2\text{CO} \rightleftharpoons \text{CO}_2 + \text{C}$ . The carbon produced is deposited on the iron contact mass during the reducing phase and reacts with the steam subsequently introduced, with the reformation of carbon monoxide during the steaming operation, this carbon monoxide contaminating the hydrogen, thus:  $\text{C} + \text{H}_2\text{O} = \text{CO} + \text{H}_2$ .

We find, however, that the intermittent method, which in its usual form gives hydrogen containing from 1 to 2 per cent of carbon monoxide, may be modified in such a way as to give hydrogen of the high purity of electrolytic hydrogen, the cost remaining approximately the same as for the ordinary impure water gas hydrogen, by utilizing for reduction, instead of water gas, a gas containing sufficient carbon dioxide to prevent the separation of carbon according to the above equation. This reducing gas is obtained easily and cheaply by a modification in the method of manufacturing the water gas.

We obtain in this way hydrogen completely free from carbon monoxide and containing as its sole impurity only a little nitrogen, while by suitable modifications of the method of manufacturing even this nitrogen content may be brought down in such a way that hydrogen of 99.9 per cent purity and even higher, is produced directly from water gas without any subsequent purification, save that afforded by an iron oxide-lime purifying box of the usual type. This complete elimination of nitrogen is, however, of course not necessary for ammonia, but is desirable where the hydrogen is to be used for other purposes; for instance, for the hardening of fats.

The following typical analyses illustrate the purity of the hydrogen produced by our process, sample 1 being manufactured without special precautions against nitrogen content, sample 2 with such precautions:

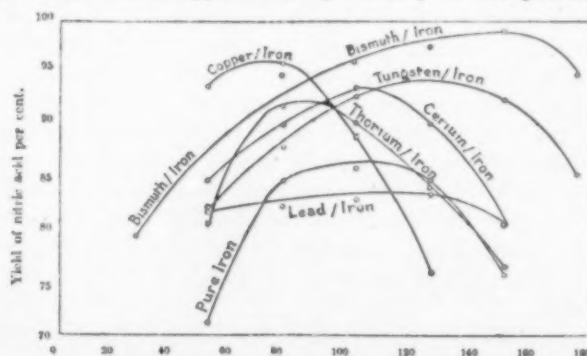
	Sample 1, Per Cent	Sample 2, Per Cent
Hydrogen .....	99.81	99.94
Carbon monoxide .....	0.00	0.00
Carbon dioxide .....	0.00	0.00
Nitrogen .....	0.19	0.06
	100.00	100.00

For the synthesis of ammonia itself, nitrogen and hydrogen, mixed in the proportions required, are compressed to a high pressure in order to increase the equilibrium value for ammonia at the temperature at which the catalyst becomes active, this pressure having as its second effect a very considerable increase in the reaction velocity of ammonia formation.

Since the power required for the compression of a gas from a pressure,  $P_1$ , to a second pressure,  $P_2$ , is given by the equation:

$$W = k \log \frac{P_1}{P_2}$$

while the equilibrium ammonia content for a given temperature varies approximately directly as the pressure,



Velocity of passage of gas mixture in litres per hour (at room temperature) per c.c. of free space in catalyst chamber. Temperature =  $700^{\circ}\text{C}$ . Each c.c. of free space = 20 sq. cm. of catalytic surface.

FIG. 2—OXIDATION OF AMMONIA



it follows that from the point of view of compression economy, it is advantageous to work at as high a pressure as is compatible with the strength of materials and smoothness of operation. It is not, however, possible in practice to work at a much higher pressure than 200 atmospheres, and we find 180 atmospheres to be a very suitable working pressure. The very considerable increase in reaction velocity at increased pressure is, further, an additional reason for the use of as high a working pressure as possible.

The catalysts which are available for the promotion of the synthesis, neglecting rare metals of the platinum group, consist of uranium and iron. Uranium, while capable of giving decidedly higher yields of ammonia per passage than iron, possesses the drawback of being only prepared and regenerated with difficulty and of being rapidly rendered inactive by traces of water or of air in the reacting gases.

For this reason we find it preferable to employ, as is done in Germany, iron containing traces of other bodies as promoters, taking advantage especially of the cumulative action of two or even more promoters contained simultaneously in the catalyst.

In view of the lack of published results as to the actual percentage of ammonia obtained in practice from iron catalysts, the following typical figures from the relation between the time of contact of the nitrogen-hydrogen mixture with the catalyst and the ammonia percentage for an iron-potash catalyst may perhaps be of interest. The third column gives the yield of ammonia in kilos, per hour per cubic foot of catalyst space, provided that the ammonia formed is totally removed in the course of circulation, a condition which may be very nearly approached by employing a refrigerator almost at the solidifying point of ammonia ( $-77$  deg. C.) with a rate of circulation such that the ammonia percentage in the gas is not too low. The temperature in this case was, as is usual, not uniform throughout the catalyst column, but varied from about 650 deg. C. at the beginning of the column to about 600 deg. C. at its end.

Time of Contact with Catalyst	Ammonia in Gas, Per Cent	Yield of Ammonia in Kilos. per Hour per Cu. Ft. of Catalyst Space
13 seconds	0.8	6.46
26 seconds	1.4	3.03
66 seconds	2.7	2.33
105 seconds	3.1	1.78
18 minutes	3.7	0.89

The most economical rate of working practice will, from the point of view of power, not necessarily be that at which the highest yield of ammonia per hour is obtained, but will be modified by the efficiency of the heat and cold interchangers and by the completeness of the elimination in the refrigerator of the ammonia formed.

Since the method employed for the complete conversion of the compressed hydrogen-nitrogen mixture into ammonia consists in passing it alternately over the heated catalyst and through this refrigerating system respectively, with alternate formation of a certain percentage of ammonia and its removal in a liquid condition, the cost of operating the process, starting with the compressed gases, consists therefore of the supply of and abstraction of sufficient heat to compensate for radiation and for the deficiencies of the heat and cold exchangers, the efficiency of the heat exchanger being very considerably increased by the by no

means negligible heat of formation of ammonia itself. For the economic efficiency of the process too great care cannot therefore be paid to the construction of the exchangers connected with the heated reaction vessel and with the refrigerator respectively.

The maximum temperature which can be employed in the refrigerator is determined by the ammonia content of the gas to be separated, and by the pressure at which the synthesis is being carried out, it being necessary, since the first portions of the ammonia are formed more rapidly than successive increments, to effect as complete as possible a removal of all ammonia formed before re-passing the residual gases through the catalyst column. The following table gives the percentage of ammonia theoretically left in a gas at 150 and 200 atmospheres respectively after passing through a refrigerator at the temperature shown:

Temperature, Deg. C.	150 Atm., Per Cent	200 Atm., Per Cent
0	2.7	2.1
-10	1.9	1.4
-20	1.2	0.9
-30	0.76	0.57
-40	0.47	0.35
-50	0.25	0.19
-60	0.13	0.1

The construction of the ammonia retorts presents considerable difficulty not only on account of the high pressure, together with a temperature approaching a red heat, but especially by reason of the rapid deterioration of the wall of the vessel under the influence of the ammonia mixture at elevated temperatures. In order to reduce this undesirable effect to a minimum the reaction vessel may be constructed of a material as resistant as possible to the action of ammonia and surrounded by a nitrogen jacket at the same pressure as that to which the nitrogen-hydrogen mixture in the catalyst chamber is subjected, the whole being surrounded by a wall capable of resisting the pressure, or other precautions must be taken so that the wall which bears the pressure does not become weakened. The manner in which a retort bursts, when this undesirable accident occurs, is a matter of considerable interest to the operator. A burst (as distinguished from an explosion due to admixture of air) results, as far as our experience goes, in a clean split, unaccompanied by fragments. We, nevertheless, take every precaution against accidents, especially with full sized retorts, by placing the reaction vessels in pits preferably out of doors.

The choice and adoption of a suitable method of heating is by no means easy. Electric heating presents drawbacks in practice, some of which are not apparent on theoretical grounds and for this reason a system of heating has been adopted in Germany according to which air is injected into the catalyst chamber in such a way that the requisite reaction temperature is reached and maintained by internal instead of external combustion. The method possesses the advantage of making possible the use of retorts which are simple in construction, but is, on the other hand, somewhat liable to give rise to explosions owing to incomplete combustion of the comparatively small amount of air necessary to maintain the temperature, this air, if not burnt, by reason of a too low temperature in the retorts or for other reasons, accumulating throughout the entire plant until a mixture results containing oxygen in proportion sufficient for explosion. We ourselves have

given very considerable attention to the subject of the most suitable methods of heating, and are adopting a system which seems to combine simplicity of working with a high degree of safety.

Passing to a short consideration of the economic side of the process, the cost per ton of synthetic ammonia may be summarized from a point of view of energy in the statement that about  $5\frac{1}{2}$  tons of fuel suffices both for the production of the necessary hydrogen, and for the generation of the power required for nitrogen production, for compression, circulation, refrigeration, etc. The labor factor in the process is small, but on account of the comparatively high initial cost of the plant, the dead charges per ton of ammonia work out at rather a high figure. The cost of synthetic ammonia under normal conditions in this country should work out at about £10 to £12 per ton.

The synthetic ammonia, when produced, has for the majority of uses to be fixed as an ammonium salt by means of a suitable acid, or it may be oxidized to nitric acid, which may itself, if required, be used for ammonia fixation. It is at present usual to fix ammonia as the sulphate, either by direct neutralization or by interaction with other sulphates, such as calcium sulphate, without the use of free sulphuric acid.

Ammonium nitrate possesses certain advantages by reason of its high nitrogen content and particularly because no extraneous acid is necessary for its manufacture. It is, however, deliquescent and for this reason cannot be transported in sacks.

The oxidation of ammonia to nitric acid in presence of platinum was discovered by Kühlmann as long ago as 1830. The process has, however, only become of technical importance since its development by Ostwald, who in 1902 proposed as a catalyst compact platinum covered with platinum black, the ammonia and air being led over the catalyst with a high velocity in order to minimize decomposition of the oxides of nitrogen formed by the oxidation.

The process, as carried out at the present day, takes three forms:

1. Oxidation by means of a platinum plug (Ostwald's process).
2. Oxidation by means of an electrically heated platinum net.
3. Oxidation by means of base metal catalysts.

According to the Ostwald process a mixture of air and ammonia is passed along a heat interchanger at the end of which a platinum plug is situated. The yield is good, averaging 90 per cent or even higher, but the regulation of temperature is not so easy as in the second type of platinum plant in which electrical heating is employed. The main Ostwald patent has now expired. The use of an electrically heated net of compact platinum is finding increasing favor and presents many advantages over a plant of the Ostwald regenerative type.

It may be preferable at this stage, instead of discussing the various more or less well-established plants employing platinum, to illustrate briefly the results which are obtainable with base metal catalysts taking, as typical examples of these, catalysts consisting of iron containing various promoters, and considering for the present only binary mixtures. The present war restrictions prevent a full description being given of the exact plant and conditions used for the oxidation, but

the results about to be described show most decidedly that satisfactory results may be obtained without the use of platinum. We employ for the oxidation of ammonia not only air but also air enriched with the oxygen obtained as a waste product from our nitrogen plant, or even pure oxygen, the slightly increased cost of materials being more than compensated by greatly increased output and by other even more important factors.

The activating influence on iron of certain bodies such as bismuth or copper was well known at the time we began working in this direction, and the results obtained during preliminary tests with known catalysts amply justified a systematic study of the activation of iron for the oxidation of ammonia. Thus ammonia, mixed with ten volumes of air (containing sufficient oxygen for complete oxidation) gave in a preliminary experiment a yield of nitric acid equal to 90 per cent of the theoretical.

The results shown in Table I were obtained at 700 deg. C., the ammonia being supplied with an amount of oxygen sufficient but not in excess of that required for its complete oxidation to nitric acid.

It will be seen on referring to Fig. 2 that the efficiency of pure iron for the oxidation of ammonia is very appreciably raised by the addition of cerium, thorium, bismuth, tungsten, or copper, the time of contact necessary for the maximum yield of nitric acid varying, as would be expected from the complicated nature of the reaction, with the particular promoter used. For instance, the optimum of contact is, for the conditions employed, about 0.01 second for bismuth-iron, 0.015 second for cerium-iron, and 0.02 second for iron-thorium. Lead exerts a curious flattening influence on the curve, the yield of nitric acid being almost independent of the time of contact.

Antimony, from its relation to bismuth, might have been expected to exert a similarly high activating effect. On testing this, however, transitory high results were obtained (91 per cent yield with a time of contact of 0.02 second), but probably owing to the volatilization of antimony oxide from the seat of reaction, a curve was obtained, after running for some time, more or less agreeing with that for pure iron.

The alkali metals as typified by potassium hydroxide appear to have little effect on the activity of iron, while calcium was found to depress very considerably the maximum yield of nitric acid, the same effect being obtained with zinc and with manganese.

Passing to a consideration of the economic side of the manufacture of nitric acid by the oxidation of ammonia, it will at once be seen that by virtue of the high speed of passage of the reaction gases over the catalyst, a relatively small catalyst chamber will suffice for the oxidation of a comparatively large amount of ammonia per hour, and that, secondly, since practically no power is required for the operation, the actual conversion costs, exclusive of that of the materials necessary, will be low. The power required for the production of 1 ton of nitric acid from ammonia should not exceed 0.015 kilowatt-year, exclusive of the cost of condensation and of concentration, a process which we are carrying out economically without the use of sulphuric acid.

Finally it may be of interest to compare, from a point of view of power, the relative efficiencies of the



TABLE I

Catalyst	Time of Contact in Seconds	Yield of Nitric Acid Per Cent
Iron	0.03	71.0
"	0.02	82.5
"	0.015	83.5
"	0.012	82.5
"	0.01	75.0
Iron-thorium	0.03	79.0
"	0.02	88.5
"	0.015	87.3
"	0.012	82.0
"	0.01	75.6
Iron-cerium	0.03	82.5
"	0.02	87.0
"	0.015	90.0
"	0.012	87.0
"	0.01	79.0
Iron-bismuth	0.06	78.0
"	0.02	90.0
"	0.015	92.0
"	0.012	93.4
"	0.01	94.6
"	0.0086	91.0
Iron-tungsten	0.03	80.3
"	0.02	85.2
"	0.015	85.3
"	0.012	89.0
"	0.01	89.0
"	0.0086	83.0
Iron-copper	0.03	90.0
"	0.02	92.0
"	0.015	86.0
"	0.012	75.0
"	0.01	68.0
Iron-lead	0.03	80.0
"	0.02	80.4
"	0.015	81.0
"	0.012	81.4
"	0.01	81.8
"	0.0086	79.0
Iron-antimony	0.03	80.5
"	0.02	82.0
"	0.015	82.5
"	0.012	78.8
"	0.01	75.0
Iron-potassium	0.03	75.0
"	0.02	81.0
"	0.015	83.0
"	0.012	82.0
"	0.01	77.4
Iron-uranium	0.03	77.5
"	0.02	81.0
"	0.015	82.0
"	0.012	78.5
"	0.01	77.0
Iron-calcium	0.03	36.0
"	0.02	58.0
"	0.015	64.0
"	0.012	63.0
"	0.01	57.0
Iron-zinc	0.06	51.0
"	0.03	62.0
"	0.02	67.0
"	0.015	60.0
"	0.012	37.0
Iron-manganese	0.03	51.0
"	0.02	65.0
"	0.015	75.0
"	0.012	79.0
"	0.01	76.0
"	0.0086	69.0

three most important methods for the fixation of atmospheric nitrogen, namely, the arc process, the cyanamide process, and the direct synthesis of ammonia from its elements.

In making such comparison it will be seen that in the arc process electrical energy alone is involved, while for the direct synthesis of ammonia a mixed requirement of coke (for hydrogen production, steam generation, etc.) and of power (for compression, etc.) is involved. Thus in order to obtain comparative figures it is necessary to translate the coke and other fuel required per ton of fixed nitrogen into units of power. The power equivalent of 1 ton of coke or coal is the number of units of electrical power which that ton of fuel would be capable of producing if it were utilized for that purpose under efficient conditions. This may be taken at 1500-1600 kilowatt-hours or 0.18 kilowatt-year.

By the arc process 1 kilowatt-year of power will

produce about 600 kilos. of nitric acid or 130 kilos. of fixed nitrogen. For the production of 1 ton of fixed nitrogen (as cyanamide) by the carbide-cyanamide method, about 2 kilowatt-years of power, plus 3 to 3½ tons of coal and other fuel are required, making a total power (converting coal into kilowatt-years as above) of 2.6 kilowatt-years per ton of fixed nitrogen. In other words, 1 kilowatt-year by the cyanamide process will fix 380 kilos. of nitrogen as compared with 130 kilos. by the arc process.

Turning to the power required for the direct synthesis of ammonia, 6½ to 7 tons of fuel (coke and coal) are required for the generation of the necessary hydrogen and for the production of all power required for the fixation of 1 ton of nitrogen as ammonia, including the separation of the nitrogen itself from the atmosphere. Converting fuel into power, as before, about 1.2 kilowatt-years are required for the fixation of 1 ton of nitrogen by direct synthesis of ammonia. Thus 1 kilowatt-year will fix about 830 kilos. of nitrogen, compared with 380 by the cyanamide method and 130 by the arc process.

These figures clearly show that from the point of view of power and material the direct synthesis of ammonia is more than twice as efficient as the cyanamide process, and more than six times as efficient as the arc process.

These striking results are modified slightly by the difficulty in operating the direct synthesis and by the cost of labor, which is lighter than for cyanamide, together with the necessary dead charges, which are heavier.

The direct synthesis of ammonia, on the other hand, accompanied where necessary by the subsequent oxidation to nitric acid, presents by far the most economical method of fixing nitrogen at present known, and if only by virtue of the urgent need of the land for cheap, abundant, and non-seaborne fertilizers, deserves every attention from a standpoint of national economy.

**Effects of Fuel Shortage in Neutral Countries.**—Shortage of fuel, which, according to Commerce Reports, is daily growing worse in the Scandinavian countries, induces extraordinary efforts at economy, not so much for the purpose of saving money as for the conservation of the total fuel supply to last through the indefinite period of famine. All the governments, State and city, are doing their utmost in the way of regulations and limitations on the travel in trains, trams, and automobiles and in the use of coal, wood, coke, and gas for cooking and all other purposes. The demand for more economical steam boilers and engines, and for oil and gasoline engines, heating plants, and domestic cooking apparatus is greater than ever before.

In Copenhagen all kinds of apparatus for economical cooking are being tried, including small, cheap forms of charcoal burners adapted for short blocks of hardwood. Several forms of fireless cookers (locally known as "hay boxes") are being extensively tried.

One of the important interests affected by the coal shortage in Denmark is the manufacture of cement. These works are now closing down, and this will cause disturbance in the building trades, which are already hampered by the shortage and high prices of materials and labor. Thus house room becomes scarcer and rents advance.



## Synopsis of Recent Metallurgical and Chemical Literature

### Electric Smelting of Iron Ores in Northern Sweden.

—A recent issue of the "Jern-Kontorets Annaler" reproduces in a slightly abridged form a memorandum drawn up by Mr. J. A. LEFFLER, in which he investigates a proposal to install electric furnaces in the north of Sweden for smelting pig iron. The committee recommended the installation of four plants with six furnaces in all to produce 65,000 to 70,000 tons of pig iron per annum, using from 110,000 to 120,000 tons of ore and about 25,000 tons of charcoal.

In his investigation the author makes, among others, the assumption that to smelt one metric ton of pig iron from the Luleå or Gällivare ores, 1.6 ton of ore and 0.4 ton of charcoal are required, and 0.272 kw.-year of electric current. As explained by him in detail, such a low consumption of current can only be attained by installing four furnaces of a total of 9000 kw., one as a receiver unit and three working continuously. This would make it possible to utilize 92 per cent of the purchased power, while with one furnace only the useful percentage would only be 83 per cent, which is the average result attained during the three years' working in 1913-1915 at the "Jern-Kontoret's" experimental plant at Trollhättan.

The capital outlay at Luleå would be about \$417,000 for the plant itself and about \$102,000 for dwellings for officials and workmen, while for Gällivare the corresponding figures would be \$460,000 and \$114,000 respectively. There would be six officials and seventy-five workmen with their foremen, and the assumed output at each place would be 30,000 metric tons (33,100 short tons) per annum. For the cost of production of one metric ton of electric pig iron the author submits the following estimates:

ESTIMATE OF COSTS OF PRODUCING ONE METRIC TON OF PIG-IRON BY ELECTRICITY			
	At Gällivare		At Luleå
800 kg. ore	\$4.44		\$5.25
800 kg. briquettes			
Limestone		.16	.10
400 kg. charcoal		5.97	4.40
0.272 kw.-year		3.51	4.95
Electrodes		.45	.40
Repairs and maintenance		.89	.81
Wages		1.58	1.32
Management and sundries		.55	.47
Royalty		.34	.34
Sinking fund		.87	.79
Rents		1.40	1.32
Freight to Luleå		1.18	....
Total cost		\$20.44	\$20.15

The freight from Luleå to Gävle and unloading the iron into railway cars would cost \$1.09 per ton. It will thus be seen that the northern pigs would cost at Gävle about \$21.40 per ton, and therefore could not compete with the pig iron obtainable there from the blast furnaces at \$17.50 to \$19.00 per ton for basic, and at \$19.00 to \$20.25 per ton for acid open-hearth pig iron.

### Nitric Acid

**Nitric Acid from Coal Gas—Hausser Process.**—In the *Chemical Trade Journal and Chemical Engineer* for July 14, 1917, is given a short account of a process developed by Professor Hausser for making nitric acid direct from coal gas by igniting with a high tension spark. A large-scale experimental plant is stated to have been at work before the war at the Nuremberg gas works.

The explosion of the gas is effected in steel vessels surrounded by a water jacket, to which, in the original plant, air and gas were admitted under pressure through separate valves. Ignition of the charge then takes place by means of a high-tension spark derived from a magneto attached to one side of the vessel. The magneto is connected with, and driven from, the same mechanism as operates the valves.

The chemical reactions involved in the process are of a particularly simple nature. The nitrogen combines with oxygen to form nitric oxide:  $N_2 + O_2 = 2NO$ . The nitric oxide mixtures are then cooled and passed into a gas holder, where the necessary time is allowed for oxidation to take place on the following lines:  $2NO + O_2 = 2NO_2$ . The nitrogen peroxide formed by oxidation is finally sent forward to counter-absorption vessels, where, reacting with water, it gives rise to the formation of a mixture of nitric and nitrous acid as follows:  $2NO_2 + H_2O = HNO_3 + HNO_2$ . The nitrous acid is then oxidized to nitric acid by an excess of oxygen. In this way the acid obtained varies in strength from 30 to 50 per cent., and the weak product is in most cases evaporated and redistilled in order to provide a concentrated solution. The waste gases from the plant, still containing some nitric oxide, are treated in special washing towers, in order to recover the greatest possible quantity of the nitrous products. Generally from 2 to 3 per cent of the original nitric oxide gas is discharged with the waste products.

It is explained that, so far as can be ascertained, the original plant has now been considerably modified, particularly as concerns the explosion chamber, and the efficiency of the latest apparatus is such that expectations have been surpassed. In its new form, the plant consists of a battery of chambers or bombs, all of which are supplied from two compressors, while instead of the gas and air being compressed together the two are dealt with separately. It is essential that a high temperature should be attained during explosion, and to this end the air, after compression, is passed through a specially designed preheater operated by gas. For reasons of temperature, again, a small proportion of pure oxygen is regularly mixed with the air in the compressor. The latest form of container is fitted with four valves, driven by gearing from an electric motor, and it is the speed of this motor which determines the number of explosions per minute. It is essential that rapid cooling of the waste products should be effected, otherwise there is a tendency for the nitric oxide to undergo decomposition, and a special exhaust valve is employed for the purpose of temperature drop. Immediately on the outlet of the bomb is attached a condenser coil submerged in water, and in this coil the water resulting from combustion is thrown down and drawn off. It is customary to regulate the explosions, so that they occur in each bomb at the rate of about sixty per minute. Within limits, the greater the capacity of the bomb the larger will be the yield per unit of gas. The process is applicable to producer and all low-grade gases, and so far as the yield of nitric acid is concerned it has been shown that when employing coke-oven gas about 6¼ lb. of acid per 1000 cu. ft. of gas exploded must be looked upon as a maximum.

**Manufacture of Synthetic Rubber from Carbide.**—A communication from the Swiss Acetylene Association published in *Zeitschrift für Angewandte Chemie* is

abstracted in the *Chemical Trade Journal and Chemical Engineer*, July 14, 1917. The manufacture of acetone with a view to the production of synthetic rubber is of considerable importance in Germany at present. The importance of this new industry is indicated by the fact that some of the largest firms in Germany, such as the Konsortium für elektro-chem. industrie of Nürnberg, the Elektrotech. Werke of Bitterfeld, Farbenfab. vorm. F. Bayer & Co., Griesheim-Elektron, and others, have been occupied with this problem for some years. There are firms in Germany producing 10 to 50 tons of carbide per day in order to convert the acetylene into acetic acid and acetone, the latter being intended chiefly for the production of synthetic rubber. This new industry should be of special interest to Switzerland, since the necessary carbide will in the future be available in large quantities in that country. After the war the export of carbide will be considerably reduced, and this product will therefore become much cheaper. On the other hand, the price of rubber will remain high for several years. In order to protect this young industry it is suggested that Switzerland should impose a duty on imported rubber, since the countries which export crude rubber will doubtless put an export tax thereon.

**Physical Basis of Color Technology.**—In the *Journal of the Franklin Institute* for July and August, M. LUCKIESH gives a very interesting and comprehensive discussion on the value of physical tests in color technology, with much practical data on pigments, dyes and glasses. In the introduction he says that a perusal of the literature on colored media and a general acquaintance with color industries have led to the conclusion that the chemistry of such substances greatly dominates the physics in color technology. In fact, much of the physics of color is so little used in some of these activities that it is either not generally understood by color-technologists or its value is underestimated. Spectral analyses, the quantitative determinations of the spectral characteristics of colored materials, provide the foundations for many important aspects of color technology, and without such data some work progresses more or less blindly. With such data, and those derived from less analytical methods, many interesting facts of color technology can be bared and various factors can be determined which are unapproachable from the viewpoint of chemistry or from ordinary inspection. The following extracts are interesting:

"Owing to the indefiniteness and limitations of the data yielded by most of the so-called colorimetric methods, and the difficulties attending the use of the monochromatic colorimeter at present, the paper is confined almost entirely to spectrophotometric data and their uses. Many instances arise when the degree of absorption for ultraviolet and infra-red rays is of interest. The former can be determined readily by spectrophotography and the latter by means of such energy-measuring instruments as the bolometer or thermopile. Other methods are available, which may readily be ascertained if necessary.

"For the purpose of the paper three classes of colored media are represented and discussed, namely, pigments, dyes and vitrifiable colors or colored glasses. Pigments are distinguished from dyes by their insolubility in their vehicle, while dyes are soluble. This distinction may appear arbitrary, especially in some cases; however, it

is employed to some extent, and is a convenient classification. Pigments may be distinguished from paints in that the latter are pigments in a vehicle or medium. Vitrifiable colors are those which impart color to glass and to similar substances. Among pigments are found two general classes, one in which each particle is homogeneous, and the other in which a colorless base has been colored by depositing coloring matter upon it.

"The chief use of the data derived from such spectral analyses is that of establishing the spectral character of the pigment. The general value of such data needs no defence, for it is the actual foundation of the pigment as a coloring material. Its purity is thus established; its influence in color-mixture may be predicted; the purity or desirability of a color resulting from various mixtures of pigments whose spectral analyses are available may be predetermined, and in many ways such data are useful. It is quite beyond the scope of a single paper to discuss all the physical uses of such data; besides, it is the intention to confine the discussion chiefly to aspects which are likely to be less commonly appreciated.

"The mixture of dyes is governed by the same subtractive principles of color-mixture as the mixture of pigments, although the greater number of dyes and the more exacting or delicate applications of dyes in industries, in the making of accurate filters, etc., make their spectral analyses of perhaps more importance than in the case of pigments. Certainly a knowledge of the spectral characteristics of dyes, as in the case of pigments, makes for an ease and certainty in making, and in visualizing mixtures which cannot be enjoyed without such data. It is beyond the scope of this paper to present a complete discussion of the usefulness of spectral analyses of dyes or to present the spectral analyses of all the dyes available.

"The uses for spectral analyses of dyes are manifold, as in the case of any class of colored media. In general they provide a physical basis for systematic color-mixture, besides providing the necessary information for choosing dyes for many purposes. In many aspects of color-technology only the integral or subjective color is finally of interest, but the author cannot refrain from emphasizing that even in such cases an intimate knowledge of colored media and their mixtures cannot be attained without spectral analyses, and that the combination of dyes becomes systematic with such data available.

"With spectrophotometric apparatus well maintained, a complete spectral analysis can be made in about an hour, although there is much room for improvement in such apparatus which will result in the saving of time. However, this is not a serious matter, because for a given coloring material only one analysis need be made, as will be shown later, to provide information for all degrees of concentration or depth of solution. The author has available hundreds of spectral analyses which, after once obtained, are a perpetual source of information."

#### Electroplaters Establish Research Chemist

The American Electroplaters' Society is to support a chemist at the United States Bureau of Standards to do research work in electroplating, and have also appointed a committee at the request of the same bureau to assist in standardizing electro-deposits on war supplies.



## Recent Metallurgical and Chemical Patents

## Petroleum Technology

**Synthetic Hydrocarbon Compounds.**—LOUIS B. CHERRY of Kansas City, Mo., patents a method of changing a low-gravity hydrocarbon compound into a compound of higher gravity and lower boiling point by the aid of electricity. The apparatus is shown in Fig. 1 and comprises a still 1, provided with a suitable

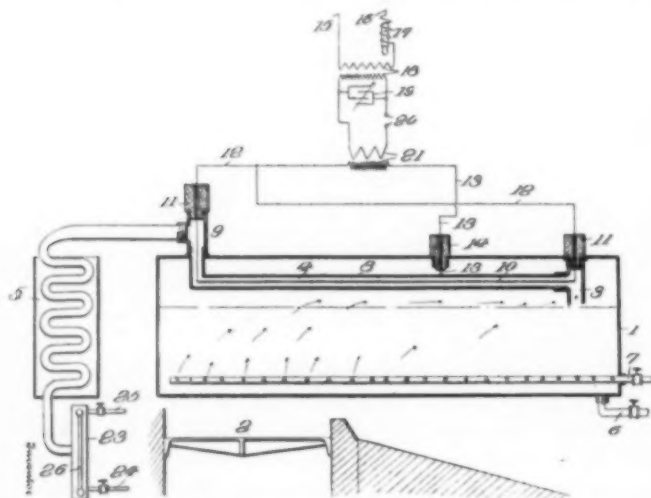


FIG. 1—DIAGRAM OF APPARATUS

heating means 2, and an offtake pipe 3. The treating chamber is shown at 4 and a condenser at 5. Fluid supply pipes are shown at 6 and 7, the latter for discharging a different fluid into the bottom of the still. The treating chamber 4 is made of metal or other good conductor of electricity. The wall 8 of the treating chamber forms one electrode, the other being shown at 10 extending through the tube.

The power is supplied through wires 15, 16, from any suitable source of preferably alternating current and is supplied to the wires 12, 13, through the medium and control of any suitable adjustable inductive resistance 17, any suitable high-tension transformer 18, any suitable adjustable condenser 19, any suitable spark gap 20, any suitable (either adjustable or non-adjustable) oscillation or high-frequency transformer 21, or otherwise, to produce a bipolar oscillatory high-frequency silent electric discharge across the treating chamber back and forth between the electrodes 8, 10. The current should be of such nature and so controlled as to avoid sparking or arcing and to provide the oscillatory silent discharge of high voltage and high frequency, and yet so that the current is under convenient manual control to permit varying the frequency thereof to suit the peculiar conditions that may arise during any operation and the particular hydrocarbon compound product desired.

If it is desired to raise the gravity and lower the boiling point of a comparatively low gravity hydrocarbon distillate of the paraffin series, the liquid compound is introduced into the still through the pipe 6 (if need be under the required pressure to overcome the pressure in the still), and the flow of liquid is controlled and is approximately constant to maintain the desired liquid level in the still as the liquid is vaporized in the still and passed off through the

electric treating chamber. During the operation of the still, a constant flow of either free hydrogen or hydrogen carrying gas or compound is discharged into the liquid in the still through pipe 7. (1,229,886, June 12, 1917.)

## Iron and Steel

**Carborundum as a Carbon and Silicon Furnishing Agent.**—A process of making cast iron from steel scrap by the addition of carborundum is patented by J. E. JOHNSON, Jr., of New York City. The process is described in the patent specification as follows:

"In carrying my invention into effect in utilizing steel-scrap, I melt down by any suitable and appropriate means, a quantity of steel-scrap so as to produce a molten bath of the same. Into this bath, I introduce and thoroughly mix therewith, a suitable quantity of carbide of silicon, preferably in amorphous form. As the carbide of silicon dissolves in the bath, the silicon will unite with the iron and will leave the carbon in the nascent condition, and in this condition the carbon will readily combine with the steel. The combination of the carbon and silicon with the steel is assisted by the fact that heat is developed by the disassociation of the constituent elements of the silicon carbide. It will be understood that I introduce sufficient carbide of silicon so that the final metal produced shall contain not less than 2 per cent and preferably 3 per cent of carbon, constituting cast iron.

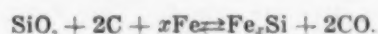
"Instead of incorporating all of the carbon necessary, by the method of procedure just described, I may first introduce in the ordinary way into the bath of steel, as much carbon as it will readily take up, and then supply the remainder of the carbon necessary, and the necessary amount of silicon, by mixing carbide of silicon with the bath, in the manner described."

If it is desired to add phosphorous also, this can be done by charging the bath with a suitable phosphate, the result being that the silicon in the bath will reduce the phosphate so that it will combine with the metal. In this action the amount of silicon will be correspondingly lowered, and the necessary degree of carbonization will be effected without the presence of excessive silicon. (1,231,259 June 26, 1917.)

## Ferroalloys

**Production of Ferrosilicon in the Blast Furnace.**—J. E. JOHNSON, Jr., of Hartsdale, N. Y., patents a process of producing ferrosilicon of high silicon content in the blast furnace. The process is described in the specification as follows:

In carrying my improved method into effect, I make use of a form of blast furnace, in a general way similar to that now universally employed for smelting ores, and I charge the same with ore and fuel in the usual and well known manner. I introduce at the base of the charge, through the usual twyers, a blast which is rich in oxygen as compared with the usual blast of atmospheric air, the result of which is the production of a much higher combustion temperature than is available in the furnace as ordinarily operated, and a correspondingly increased reduction of the silica. The reactions in this operation may be expressed by the following formula:





Where atmospheric air is employed in the blast there is about  $3\frac{3}{4}$  times more by weight of nitrogen than there is of oxygen, and since, other things being equal, the temperature obtainable is inversely proportional to the weight of the products of combustion, the temperature produced is only about  $\frac{1}{3}$  as high as would be produced by a blast of pure oxygen. In other words, the nitrogen in such large proportions in the blast acts as a dead weight on the combustion and keeps the temperature down to such point that the reduction of silica is confined to limits in which the final product contains a comparatively small per cent. of silicon, rarely above 16 per cent.

By my invention, by employing a blast rich in oxygen the increased temperature of combustion is very marked, and if pure oxygen were employed the gain would be so enormous that it would greatly exceed the requirements for the end in view, and since the increase of temperature need be only about one-third higher than is now obtainable with the use of atmospheric air, I find it sufficient for my purpose to employ a blast in which the oxygen and nitrogen will be of equal weights, or in approximately that proportion. A mixture of this character is more economically produced commercially than pure oxygen, and such mixture is sufficiently rich in oxygen to obtain the temperature required, for the reduction of the silica on the desired increased scale, and for the creation of the amount of heat available at that temperature to bring about such reduction.

Ferro-silicon as most generally employed in metallurgy, contains about equal proportions of iron and silicon in order to enable it to combine under the most favorable conditions with the molten metal in which it is to be incorporated. A blast in which the nitrogen and oxygen are mixed in equal or substantially equal proportions I have found admirably adapted for producing that temperature of combustion which will bring about the reduction of the silica and iron in the proportions mentioned, and a blast mixture of this character may be economically and conveniently produced and with a far smaller plant than is required for a richer mixture or for pure oxygen. (1,231,260 July 31, 1917.)

#### Abrasives

**Abrasives from Nephelin Syenite.**—HERBERT T. KALMUS of Brookline, Mass., has patented a process of treating nephelin syenite (consisting principally of silicates of aluminium, potassium and sodium) for the production of aluminous abrasives. The patent is assigned to the Exolon Company, of Cambridge, Mass. The nephelin syenite is pulverized and dissolved in a digester. The dissolving operation is carried out by sulfitation with from five to ten times the weight of the silicate, of a two per cent water solution of sulfur dioxide. In the sulfiting operation most of the aluminium, sodium and potassium contents, and a considerable portion of the silicon content, are dissolved. The mass in the digester containing the insoluble residue is then fractionally desulfited by the introduction of steam. The first part of the desulfitation is carried on until all, or nearly all, of the silica in the solution, is precipitated, and then discontinued. This silica precipitate (which may be silica, silica hydrate, hydrated silica, silicic acid, or any similar compound of silica), together

with the insoluble residue, is removed by filtration and the solution is then further desulfited to precipitate the aluminium content. The aluminium content is then filtered from the solution, leaving the sodium and potassium (or alkali) content and possibly a little iron in the solution as comparatively stable sulfites and bisulfites. The aluminium content is precipitated as a basic aluminium sulfite or similar compound, and is preferably dried and calcined at a moderate temperature to drive off the water content along with a certain excess of sulfur dioxide. The resulting product is a white powder containing  $\text{SO}_2$  varying through wide limits in amount, depending upon the details of treatment, but averaging, as practiced by me, from 15 to 20 per cent by weight.

This process of treating sulfitable aluminium silicates to recover the aluminium content is described in detail in a patent to Kalmus, Savell & Blake, No. 1,148,092, dated July 27, 1915.

The calcined aluminium content, in the form of dehydrated basic aluminium sulfite, is then placed in an electric furnace and fused. During the fusion of the aluminium content, the fused mass is periodically withdrawn from the furnace and poured in thin streams to rapidly cool. The process of treating an aluminous material in an electric furnace and rapidly cooling the product during the fusion is described in a co-pending application Serial No. 26,626, filed May 7, 1915, for an electric furnace product and the method of making the same.

The fusion of the aluminium content of nephelin syenite is preferably carried out in an arc-type electric furnace which operates, in part, as an arc furnace and in part as a resistor furnace, such, for example, as the furnace specifically described in the British patent to Johnson No. 16,738 of 1896. (1,234,905 July 31, 1917.)

#### Osmotic Processes

**Electro-Osmosis.**—Several patents have been issued to BOTHO SCHWERIN, of Frankfort-on-the-Main, Germany, and assigned to the Elektro-Osmose Aktiengesellschaft of Frankfort-on-the-Main, Germany. One patent 1,230,524 June 19, 1917, relates to a method of separating substances in suspension in a liquid comprising adding a suitable electrolyte to the liquid and subjecting the liquid and the substance in sol-state therein to the simultaneous action of centrifugal force and an electric current. Another patent 1,235,063 July 31, 1917, relates to an electro-osmotic process for the separation of colloids, or, for instance, for separating the colloids and the dissolved bodies individually from a solution containing several colloids. The invention consists in subjecting the mixture to the action of an electric current in a circuit wherein are interposed one or more diaphragms the potential of which is so selected, that the constituent or constituents which cannot pass the diaphragm or diaphragms are separated, while the other constituent or constituents migrate through the diaphragm or diaphragms. By arranging several diaphragms of different charge capacity one behind the other, and desired separation of the constituents may be accomplished.

The diaphragms act in several ways. By means of indifferent diaphragms inserted in front of the poles, the electrolytes may be first eliminated. For example with an apparatus like that of Fig. 2 having the dia-

phragms 2, 3, made of parchment and a colloidal solution in the compartment between the diaphragms while the end compartments contain water the effect of passing an electric current through the solution is to separate the inorganic ions from the mixture, those of acid character migrating to the anode and those of basic nature to the cathode. The mixture may be impoverished, however, in acid or basic residues by separating the one or the other residue in increased proportion. For instance, by means of a positive diaphragm the

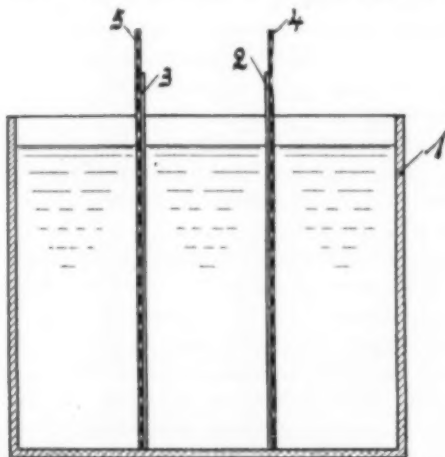


FIG. 2—ELECTRO-OSMOTIC DIAPHRAGM

acid, or by means of a negative diaphragm the basic residues may be removed comparatively more quickly, so that in the mixture the electrolytes which are suitable for the desired separation may be retained in the correct degree of concentration.

Another patent 1,235,044 relates to a process for purifying glue, gelatine and similar products by electro-osmosis.

The process comprises subjecting to an electric current between two electrodes a mixture of a gelatinous substance with an electrolyte-dissociating liquid such as an aqueous glue solution, which is separated from each of said electrodes by one or more diaphragms of various degrees of permeability.

#### Slag Treatment

**Recovery of Values from Slags.**—A process for the recovery of values contained in slags is patented by J. B. HERRESHOFF, Jr., of New York. It is described in connection with the metallurgy of copper. Employing the apparatus illustrated in Fig. 3, 1 represents a smelting furnace. This produces, say, 60 per cent matte and the slag is run into a series of settling tanks 2, 3, 4 and 5. The tank 2 will contain the 60 per cent matte and tank 3 may contain 20 per cent matte, tank 4, 10 per cent and tank 5, 8 per cent. The

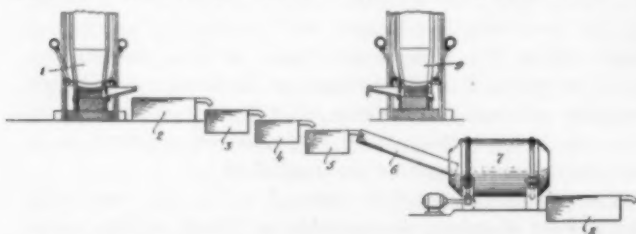


FIG. 3—ARRANGEMENT OF APPARATUS FOR RECOVERY OF VALUES FROM SLAGS

slag and matte from the furnace 1, discharges into the tank 2 and the slag separates out on top; this slag overflows and drops into the tank 3 and mixes with the 20 per cent matte and thus loses a part of its contained copper; after part of the contained copper, and with it, gold and silver is recovered in this manner. The slag then overflows into tank 4 and because of the still lower grade of matte in tank 4 a further removal of copper from the slag is effected. In like manner a further removal is effected in tank 5 and also in the long trough 6 down which, together with the purified slag, a still lower grade of matte, say 5 per cent, is run. This matte may be supplied by the smelting furnace 9. From the trough 6, the slag and 5 per cent matte discharge into the rotary mixer 7. The mixer may be of any suitable construction, preferably being provided, like the tanks and trough with a refractory lining, and may be rotated in any suitable manner. From the mixer 7 the slag and matte flow into the settling tank 8, from which the slag and matte may be drawn off separately. The process may be conducted wholly or partly continuously or intermittently. The low grade matte may be mixed sufficiently with the slag in one or more of the tanks 3, 4 and 5 and the resulting slag may be sufficiently free from copper for all practical purposes. Or the long trough 6 may accomplish the desired removal of contained copper without the tanks and the rotary mixer or a part of these elements. Or the mixer 7 may be used without the other elements. The tanks, trough, mixer and settling tank may be heated, as by the combustion of coal, charcoal or oil, so as to maintain the contents in liquid condition and preferably also so as to maintain a neutral or reducing atmosphere in contact with the materials being treated. The slag in the settling tank 8 will contain about 1 per cent of the percentage of copper in the settling tank matte in accordance with the general rule expressed above. (1,231,349 July 31, 1917.)

#### New Western Magnesite Plant

The accompanying illustration shows the new Spokane, Wash., magnesite plant of the American Fire Brick Co. Calcined magnesite and "magnesio-



MAGNESITE PLANT OF THE AMERICAN FIRE BRICK CO.

ferrite" will be made at this plant, the latter under patents issued to C. B. Stowe. The company has the northwestern rights for these patents and will use the magnesite from Stevens County, adding any desired percentage of iron.

## A Gas-Fired Welding Furnace Installation

By Charles E. Richardson

Until recently welding has been considered impossible in furnaces with city gas. Without doubt, many actual difficulties have stood in the way, but not of an insurmountable character. The chief deterrents to successful welding in gas-fired furnaces have been a number of rather vague theories and a large number of unsuccessful trials. When these failures were properly analyzed, the causes of failure could be readily seen and avoided, as will be explained in detail. The theories, when analyzed, disappeared, having no foundation.

Probably the most common of the theories was the belief that the chemical composition of the gas itself in some way rendered it unfit for use as a fuel for welding. The following may be cited as an example of the manner in which this particular theory tended to block the extension of gas in this fertile field. When the installation about to be described was first considered, a gas engineer connected with the job was very much opposed to any attempt to do the work, saying that the gas to be used did not have enough CO in it. Just what effect the CO was supposed to have could not be explained.

The belief of those designing the installation was that welding came about solely as a result of temperature plus a furnace atmosphere slightly reducing at all points. It was felt that the only relation the chemical composition of the fuel bore to the result was that it must be of such a composition as to yield a gas strong enough to give a flame temperature sufficient to make possible the securing economically of the temperatures required by the operation.

In analyzing the failures, it was found that, after excluding a few which were due to failure to obtain the necessary temperatures, the trouble lay almost with-

out exception in the matter of furnace atmosphere. While the products of combustion issuing from the flues analyzed perfectly for the work, it was found that inside, at various points, anything but perfect conditions existed. This variation was caused by lack of suitable means for automatically proportioning and mixing. To explain specifically, the air and the gas, not having been homogeneously premixed in the correct proportions, entered the furnace through the several burners in a stratified condition. Molecules of oxygen and combustible had therefore to wander around in the furnace to find one another before reacting. This meant that the steel was exposed at very high temperature to free oxygen in spots and oxidation became active enough to make the operation impossible. Of course, the molecules of oxygen and combustible did finally meet and react and the flue gases therefore looked to be satisfactory, but they merely represented the sum total of the reactions. This condition of affairs showed conclusively that if satisfactory welding was to be accomplished, means must be secured to deliver to the furnace a homogeneously premixed and perfectly proportioned mixture of gas and air, and further that said means must be automatic, so that when the proportions were once set they would hold irrespective of the quantity of mixture supplied.

The designers, therefore, knowing that it was readily possible to secure the necessary temperatures, and that suitable proportioning and mixing devices could be obtained, and feeling that the theories regarding the chemical composition of the fuel were groundless, undertook the installation described below.

The design of the furnace is shown in Fig. 1.

It is made up of two working chambers, one 32 in. deep, 14 in. wide, and 10 in. high, and the other 48 in. deep, 20 in. wide, and 10 in. high, with a preheating chamber 48 in. deep, 12 in. wide, and 15 in. high between. The working chambers can be used separately

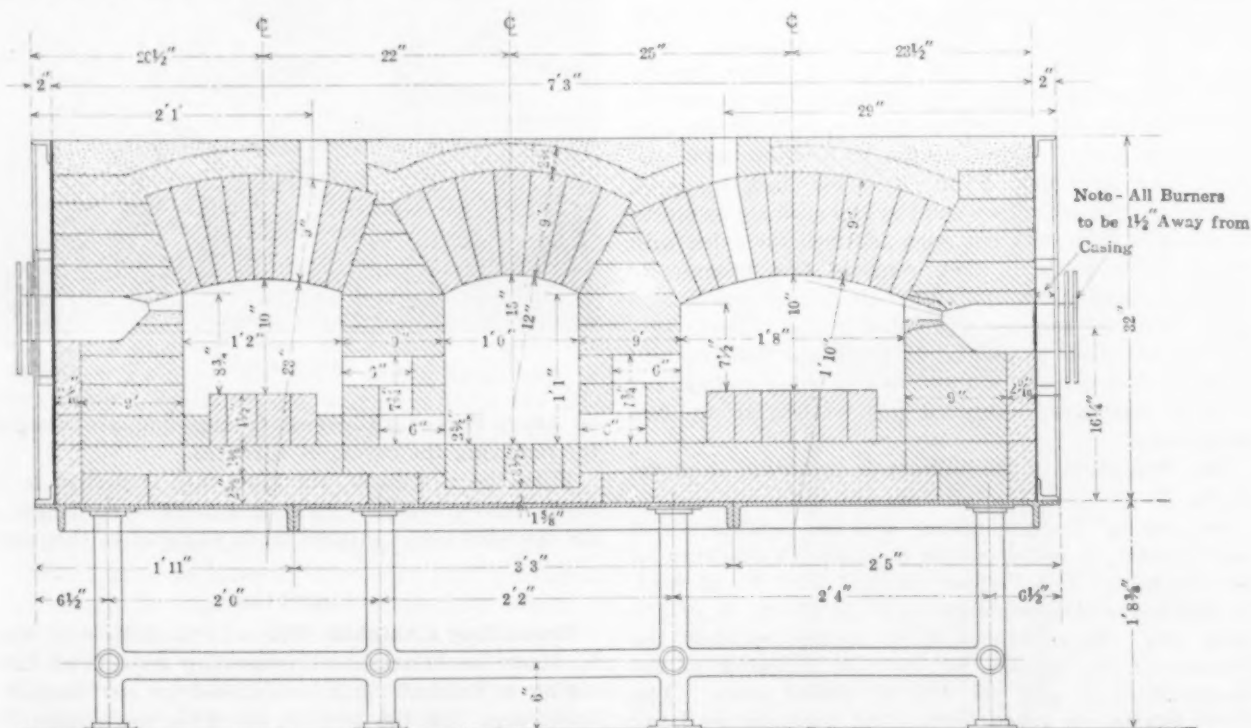


FIG. 1—TRANSVERSE CROSS-SECTION



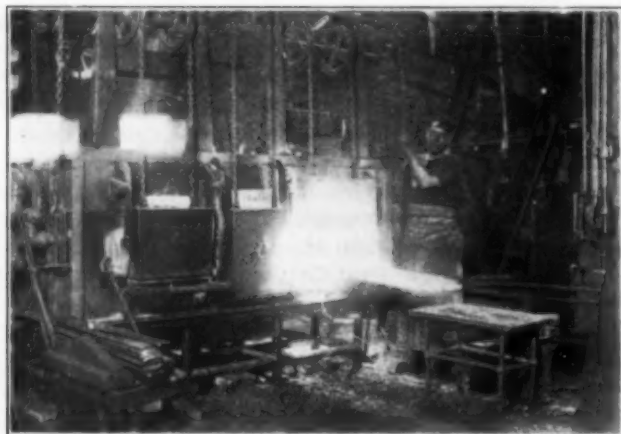


FIG. 2—WELDING FURNACE IN OPERATION

or both together according to the size and amount of work to be handled. So far, one chamber has been found sufficient to handle the tonnage required. The flue gases from the working chambers pass into the preheating chamber and out the rear of same. The working chambers are held at a temperature of between 2700 deg. Fahr. and 2800 deg. Fahr. This yields a temperature of approximately 1800 deg. Fahr. in the preheating chamber.

The furnace is fired with Surface Combustion high pressure burners, and both quantity and quality of mixture is controlled by Surface Combustion high pressure control devices.

The furnace is used in the production of machine knives for rotary cutters of woodworking and other similar machines. The finished knives consist of a slab of soft steel with a thin layer of tool steel welded on one face. The dimensions of the stock used vary greatly; an average for the soft steel slabs would be 34 in. by 8 in. by 1½ in.

The welding operation is as follows: A pile of eight or ten soft steel slabs is placed in the preheating chamber at the beginning of the day's run. When the desired temperatures have been obtained, one of these is placed in the work chamber after sprinkling the surface with borax. When heated to between 1900 deg. Fahr. and 2000 deg. Fahr., it is removed, the scale scraped from the surface and the tool steel strips placed in position flush with one edge and well sprinkled with borax. The piece is then replaced and brought to welding temperature. It is then again removed, welded under a power hammer and rolled to size. Often several reheats are necessary to finish the welding and rolling. The piece is allowed to cool after rolling, cut to size, hardened, tempered and ground to finished dimensions.

An illustration of the furnace in operation is shown in Fig. 2.

Because of the preheating and the reheats which vary greatly, it is impossible to state the efficiency of this furnace. The furnace handles 1700 lb. of work in nine hours on a consumption of 12,700 cu. ft. of 580 B.t.u. gas. These figures by no means represent the capacity of the furnace, but give an indication of the consumption of gas per ton of welded stock. The above figures are taken from a test made on the large working chamber. It is possible to at least treble the tonnage above indicated.

It was found that the mixture of gas and air, which gave the most satisfactory welds, resulted in a flue gas analysis as follows:

$\text{CO}_2 = 11.8$  per cent.

$\text{O}_2 = 0.0$  per cent.

$\text{CO} = 0.4$  per cent.

The theoretical  $\text{CO}_2$  figured from an analysis of the gas used is 12.5 per cent, which checks closely with the above figures.

The installation has been in operation for several months and the following advantages over handling the same work by oil-firing have been found:

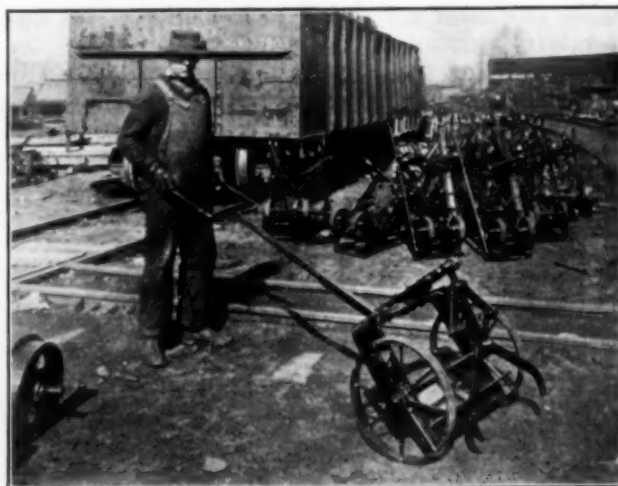
Quicker heating up, both of furnace and work, cooler and cleaner shop, increased capacity, better control of temperature and furnace atmosphere, less scale, easier to light up and operate—single valve control, and more constant composition and heating value of fuel.

The above-described furnace was designed and installed by The Surface Combustion Company of Long Island City, N. Y., at the plant of D. Lovejoy & Sons, Lowell, Mass. Gas is supplied by the Lowell Gas Light Company on a sliding scale basis, which makes gas available at a rate of approximately \$0.70 per M.

Long Island City  
New York.

### New Design of Tong Hook for Removing Covers of Furnaces

A new type of lazy tong hook shown in the accompanying illustration has just been shipped to The Braden Copper Company by the Orenstein-Arthur Koppel Company, of Koppel, Pa. The hooks are mounted



TONG HOOKS

on heavy forged two-wheel frames and are designed for removing the covers of furnaces.

With the new hook, one man only is needed to remove and replace the covers and there is no danger of the operator being injured when engaged in this work.

### Correction

**Renovating a Sulphide Mill.**—In the article by Hugh K. Moore on "Chemical Engineering Aspects of Renovating a Sulphide Mill," published in our August 1 issue, page 120, the formula for B.t.u. per square foot per minute =  $2.66 \times 10^{-2} (T_2' - T_1')$  should read as  $2.66 \times 10^{-2} (T_2' - T_1')$ .

## Luminous Devices in the War

That luminous devices, made by radium luminous paint and other luminous compounds, should prove valuable in warfare is plainly evident. Horne's Luminous Company, Ltd., of North Cheam, Surrey, England, has been making some interesting devices for use at the front. The company is an old one in this field, being the successor to the original inventor of Balmain's luminous paint, Dr. W. H. Balmain.

A luminous night marching compass, of which 100,000 are being used by the Allied armies, is one of the devices made by the company, which is very busy with Government orders. A luminous linen collar beacon painted with Balmain's luminous paint is another interesting product. These linen tabs present a luminous surface of 10 sq. in., and are for attaching to the back of the tunic so that when the first line of men go over the top they are not mistaken for enemies in the dark by the second line of men who follow.

Spiked beacons are also made in the shape of large buttons (1¼ in. diameter), the Balmain's luminous painted top being covered with transparent celluloid, and surmounted on a small steel spike ¾ in. long, which, by pushing, enters into any woodwork, and when affixed to the top of short stakes driven into the ground and placed 10 yd. apart, afford a guide to relief parties going and returning in the dark. One hundred of these 10 yd. apart serving 1000 yd., the stakes being placed in the day on fairly chosen level ground, they will act for months, taking up light each day and acting each night.

Luminous tape is another useful article for dark night operations.

This tape, if placed on the ground and secured by stakes, metal rods or stones, is prevented from being shifted by the wind.

The "tape layer" places the tape in position during the day, choosing a safe path across the country, and diverting from the straight path according to the condition of the ground. The path should be wide enough for men to march four abreast up one side of the tape and returning the other side, say, in all about 12 ft. wide. Where this is not possible the tape layer makes a break in the tape every few yards, and starts again continuously when the path is wider. Any obstacle in the way, such as a tree or post, could have a small length of tape tied round it.

But should a ditch come across the path he would lay short pieces of the tape at right angles on either side of the ditch. In case of the ditch being over 4 ft. deep, the man should have a Luminous Beacon with him and write on it the depth of the ditch, also the width, with a special pencil, and place it by the tape, when near the ditch. A No. 2 beacon would be the size for this.

Large letters can be easily composed out of this tape by nailing it up with zinc nails, such as "Fireman," "Doctor," etc., also for direction arrows.

These Luminous Beacons have been used for signalling silently by night. They are specially useful in trenches which are in close proximity to the enemy, saving the need of whispering the words of command, which causes a hushing sound, when complete silence is required for listening to the enemies' movements. A No. 2 size beacon will carry a message a distance of 20 yd., thus a No. 4 beacon would be seen over 10 yd.

away. The signalling can be either done with the Morse code or by describing large capital letters of the alphabet the reverse way, and by the hand waving them in the air. The Royal Engineers were the first to use these devices.

The tape is also very useful for R.A.M.C. work—the tape-layer by daylight choosing fairly level ground to guide the stretcher bearers—thus saving their labor in the dark, and less jolting to the wounded. Moreover, lamps afford a mark for the enemy—whereas the tape can only be seen by those immediately over it—enabling work to be done silently in the dark, the darker the better.

## Adiabatic Jackets for Calorimeters

Along with the increased use of the calorimeter for both commercial and scientific purposes there has been constantly growing a demand for improvements in the design of the jacket. This demand for improvements in the type of jacket has in view the elimination as far as possible of the exchange of heat between the calorimeter and the calorimeter jacket. This condition is desired principally in order to obtain increased accuracy in calorimetric work, and further it is desired that a calorimetric test can be made under these adiabatic conditions with the necessary time of test reduced.

These adiabatic jackets when operating properly eliminate the cooling correction. This is a desirable feature in scientific calorimetric work as it makes possible increased accuracy, and is of advantage in commercial work as it eliminates the time necessary in computation of the cooling correction and the time to take the thermometer readings, which furnish the necessary data for the cooling correction formulas.

A type of jacket which is designed to accomplish this adiabatic condition which is coming into considerable use is the vacuum walled jacket. This is the simplest type of jacket to operate, which practically eliminates radiations and is quite satisfactory for general calori-

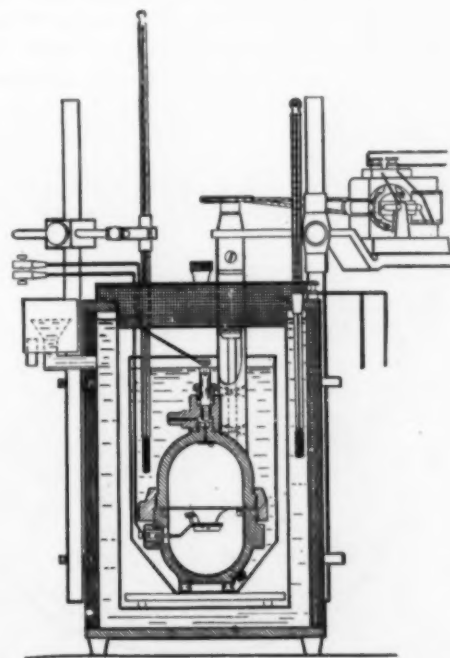


FIG. 1—THE EMERSON CALORIMETER EQUIPPED WITH DANIELS' ADIABATIC JACKET

metric work. If the temperature in the calorimeter with a vacuum walled jacket, however, is not fairly close to that of the room temperature, an appreciable exchange of heat does take place.

In addition to radiation when a test is made in a vacuum walled jacket at a temperature considerably above the room temperature, the condensation of vapor on the cover and upper walls of the jacket may introduce considerable cooling effect. A vacuum walled jacket when operated in proximity to room temperature gives satisfactory results, and except for the fragile nature of the jacket is very desirable for commercial work.

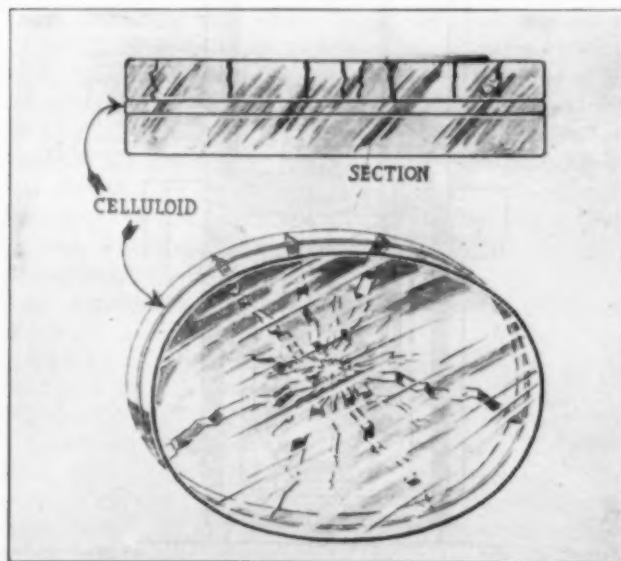
Several types of jackets have been used in which the temperature of the jacket is raised at a rate equal to the rate of rise in the calorimeter. Examples of this type are the jackets designed by Prof. T. W. Richards of Harvard and the jacket developed at the Bureau of Standards. Electric heaters are used in conjunction with stirring devices in these designs.

In the accompanying illustration is shown an Emerson calorimeter made by the Emerson Apparatus Company of Boston, Mass., equipped with a modification of an adiabatic jacket designed by Dr. Farrington Daniels of the Worcester Polytechnic Institute. In the Daniels jacket radiations are eliminated by carrying the temperature of the jacket along with the temperature of the calorimeter. The rise of temperature is obtained in the jacket without the use of electric heating coils. The jacket water itself is the heating unit, and by passing an electric current through the same its temperature is raised simultaneously with the calorimeter temperature. With the application of the current to the water jacket the temperature rises immediately and uniformly throughout the jacket.

In this manner the lag of the resistance wires of the heating coils is eliminated, as is also the stirring of the jacket water as the heat is not localized.

### New Industrial Glasses

An interesting new safety glass has been developed by Strauss & Beugeleisen, 37 Warren Street, New York City, to be used in connection with industrial masks and goggles used for protective purposes to



SHOWING THE CONSTRUCTION OF THE "RESISTAL" CRYSTAL

shield the eyes of the workmen from flying particles, dust, heat, light and injurious gases.

The feature of this new glass is the fact that while it can be cracked, it cannot be broken even with a hammer blow, while in cracking there is no flying of splinters to jeopardize the eyesight of the workman. When cracked the glass remains gas and water tight.

The construction of the glass, which is known as "resistal," is shown in the accompanying sketch. It comprises two layers of perfect optical glass, which may be either plain or curved, with a layer of celluloid interposed, the whole being welded into a solid mass.

The celluloid acts as a heat-insulating medium preventing "clouding up" due to moisture condensation.

Goggles fitted with these safety glasses have been adopted for the needs of the Aviation Corps, U. S. Army, while from the same quarter the makers have received orders for a large number of crystals for military gas mask purposes.

### An Interesting Dump Car

In the accompanying illustration, Fig. 1, is shown an interesting dump car made by the Easton Car & Construction Company, Easton, Pa. The body of this dump car may be lifted off the frame, set down on another track and run in under a hopper for loading where head

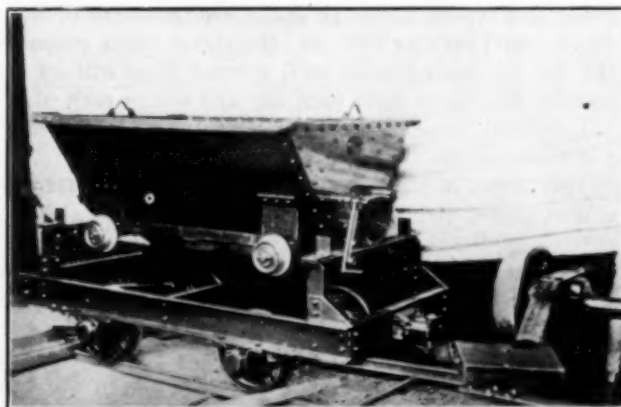


FIG. 1—DUMP CAR WITH REMOVABLE BODY

room is limited or space too narrow to permit the whole car to enter. After the car is loaded it may be hauled out, lifted by a crane onto the underframe again, and run out to the dump. The two sets of wheels and the crane lifting rings that make these operations possible are shown in the illustration.

### Old Cave Deposits of Nitrates in the South

The United States Geological Survey has investigated a cave in one of the Southern States which was worked by the Confederacy during the Civil War for potassium nitrate. This cave is said to contain at least 1,000,000 tons of nitrous earth, which, however, contains only 1 to 2 per cent of nitrate. The Survey states that it seems very doubtful whether such material can be profitably used as a source of nitrate salts. The minimum grade of caliche now worked in the Chilean fields contains 12 per cent of sodium nitrate, and though there has been much criticism of the crudeness of the methods employed there, the work is done by very cheap Indian labor, and it is doubtful whether leaner material could



be worked to advantage here, where the price of labor is so much higher. Several hundred thousand dollars has recently been expended in one of the Western States in testing the proposition to utilize low-grade nitrate. The results have been negative.

The nitrate caves in the South were worked during the Civil War by very crude methods. Generally the cave earth was shoveled into iron pots, where it was treated with water and heated over wood fires to leach out its soluble parts. The liquor was drawn from one pot into another and used for treating fresh material until it became a highly concentrated solution of nitrate salts. It was then drawn off and allowed to cool, whereupon the nitrate crystallized. The remaining liquor was then employed to leach fresh material and the crystals were separated and sacked for use.

### Personal

Mr. R. Atkinson, formerly with the Maxwell Motor Co., Inc., has recently assumed the duties of metallurgist with the Domestic Engineering Co. of Dayton, Ohio.

Mr. H. D. Batchelor has been appointed head of the Cleveland laboratories of the National Carbon Co.

Dr. C. F. Chandler, emeritus professor of chemistry at Columbia University, was reported at the time of writing to be feeling considerably better, following a period of illness.

Mr. Welton J. Crook has been ordered to the Officers' Training Camp at San Francisco. Mrs. Crook has taken over all his work and has accepted his position with the Pacific Coast Steel Co.

Mr. C. A. Crowe, formerly manager of the Grand Rapids office of the Asbestos Protected Metal Company of Pittsburgh, has been appointed to take charge of the Detroit office located in the Penobscot Building. Mr. M. W. Taber, formerly Detroit manager, has been appointed factory manager.

Dr. Colin G. Fink, for the past ten years in the research laboratory of the General Electric Company, has been appointed head of the new Chile Exploration Company laboratories located at 202nd Street and Tenth Avenue, New York City. The work in the new laboratories will be largely research along metallurgical and electrochemical lines. Dr. Fink is president of the American Electrochemical Society.

Mr. J. E. Johnson, Jr., has gone to the Pacific Coast on a professional trip requiring six or seven weeks.

Mr. Dorsey A. Lyon, who has been in charge of the Bureau of Mines station at Seattle, has been appointed to the newly created post of superintendent of all stations, with headquarters in Washington. Thomas Varley will succeed Mr. Lyon at the Seattle station. Mr. Varley has been stationed at Moscow, Idaho. Clarence A. Wright, a metallurgical engineer who has been attached to the Salt Lake City station, has been transferred to Moscow, Idaho.

Mr. Charles R. Oberfell, for some years past chemist for England, Walton & Co., leather manufacturers, Third Street, Philadelphia, Pa., and at one time president of the American Leather Chemists' Association, has resigned to become connected with the John H. Heald Co., Lynchburg, Va., manufacturer of dye-wood and allied specialties.

Mr. Howard C. Parmelee has resumed charge of the western office of Metallurgical and Chemical Engineering, with offices at 401 Boston Building, Denver, Col., succeeding Dr. Siegfried Fischer. Mr. Parmelee left the editorial staff of this paper a year ago to assume the presidency of the Colorado School of Mines, but was recently forced to retire from that position when he was not supported by the trustees of the institution in a matter of student discipline. Prior to leaving his editorial work, Mr. Parmelee was on the staff of this paper for six and a half years.

Prof. Francis A. Thomson has resigned from the faculty of the State College of Washington to accept the deanship of the School of Mines at the University of Idaho, Moscow, Idaho.

### Obituary

Mr. Joseph B. Jacoway, who ever since the organization of the Pratt Engineering & Machine Company was manager of the Atlanta sales office, passed away Aug. 14 at Prescott, Ariz. He was born at Trenton, Ga., in 1883, and was well known to the fertilizer and acid trade.

## CURRENT MARKET REPORTS

### Non-Ferrous Metal Market

*Thursday, Sept. 5.*—The features of the market have been the decline in lead and the sensational advance in silver to undreamed of levels. The other markets are practically unchanged.

*Copper.*—Strike conditions have improved slightly in the Arizona district, but the market has remained quiet and unchanged in price. Prompt Lake is quoted at 27.50 average and electrolytic at 25.50, which is a slight decline. Copper exports are now under control.

*Tin.*—Tin has advanced and declined fractionally during the last two weeks and spot Straits is slightly lower at 60 $\frac{7}{8}$  cents. Spot Banca is quoted at 58.50 to 59.00 cents. Chinese futures are offered at 54.50 cents. Arrivals in August were about 2500 tons, with total deliveries of 2150 tons at Atlantic ports and 1155 tons at Pacific ports.

*Lead.*—The lead market has been very dull. The feature has been the reduction by the Trust from 11.00 to 10.50 on Aug. 29 and to 10.00 cents on Sept. 4. Independents have met this price with corresponding reductions. Little increase in business has followed the reductions, however.

*Spelter.*—There is nothing new in the spelter market, the price remaining at about 8.00 cents, New York basis. The situation continues unsatisfactory from the producers' standpoint.

#### OTHER METALS

Antimony, Chinese and Japanese, pound.....	\$0.145
Aluminium, No. 1 Virgin, 98-99 per cent, pound.....	.46
Magnesium, metallic, pound.....	2.00-2.50
Nickel, electrolytic, pound.....	.55
Cobalt, pound.....	2.70
Cadmium, pound.....	1.50
Quicksilver, flask.....	115.00
Silver, ounce.....	.95%
Platinum, pure, ounce.....	105.00
Palladium, ounce.....	115.00

### The Iron and Steel Market

The fore part of September has witnessed the same stagnation in the iron and steel market that characterized August, but progress continues to be made

along normal lines towards the price readjustment that is needed to enable business to proceed. The mills reduced their obligations on books and buyers received a corresponding amount of material, so that the existing engagements on the part of both buyers and sellers were much less at the end of the month than at the beginning. New tonnage entered during the month was chiefly of special character, partly Government orders and partly contracts from regular customers accepted at prices which long since disappeared as ordinary market quotations.

One feature of the progress that is being made is that there are heavy shipments of the highest priced tonnage sold in the past few months, during the period in which there was one price for regular forward deliveries, and much higher prices for early deliveries, made chiefly by mills that were not entering the far forward deliveries at all. Thus a condition is being approached at which the highest priced sales will have been executed, some lower priced tonnage remaining on books, so that a decline in the general market will not disturb conditions as much as would have been the case if it had occurred one month or two months ago.

The whole trade, producers and buyers alike, are anxious that a readjustment shall take place whereby prices may be put on an equitable basis, one that will afford a fair profit to producers and one that will enable consumers to continue in business. It has been recognized on all hands for many weeks that the steel market had worked itself into an impossible position, one from which there was no escape except by a reduction from the prices commonly quoted as representing the market, such prices at 9c. to 10c. for plates, 4.50c. for bars and shapes, 8c. to 9c. for black and blue annealed sheets, and so on. These prices have been obtained only for relatively early deliveries, and when such business has been worked off the price readjustment can occur with a minimum of disturbance.

#### READJUSTMENT MAKES PROGRESS

While there has been no general decline in the finished steel market there has been progress made just the same. In all readjustments after a period of continued price advances and heavy buying the market generally yields first on scrap, then on intermediate products and finally on the finished products. In this case scrap began to decline late in June and the decline continued during July, while in August the fluctuations practically balanced. The scrap market was waiting for finished steel to catch up. Pig iron softened slightly in July as to price, while the volume of business dropped to almost nothing, and no revival in buying has occurred. Unfinished steel began to decline early in August and declines have continued to date, latest offerings of billets being at \$75, with a possibility that \$70 could be done, while in June the market had become established at a minimum of \$95.

While finished steel products have experienced no general decline as yet, plates, formerly the market leader, have dropped at least 1c. per pound, the market having formerly been established as firm at 9c. to 10c., while late in August there were many offerings at 8c. and some sales were effected at a shade

less, 8c. being the maximum of the market at this writing, for tank quality, ordinary sizes. The general decline in finished steel appears first in plates by reason of several influences, the embargo on exports, the large amount of new capacity under construction, 125,000 tons per month of new capacity being expected within about six months, and the development that the Government's shipbuilding program is not consuming plates at the moment as rapidly as had been expected. The really large consumption will not occur for several months yet, when additional capacity will be available.

#### PIG IRON

That the general readjustment in prices now started rests upon a solid foundation and is not a temporary reaction is shown by pig iron. The rapid advances that occurred March to June inclusive were predicated upon scarcity, i.e., more steel-making capacity than blast furnace capacity to supply it. In July and August the condition was accentuated, pig-iron production declining on account of scarcity of coke, while there was more steel-making capacity available than could be utilized, yet the pig-iron market declined sensibly. According to the theory previously held it should have continued to advance.

In the valley market Bessemer pig iron had reached a point in June when the minimum was \$56, valley furnaces, while \$57.50 was paid for some prompt deliveries. Late in August there were purchases for immediate shipment at \$50 and 52, and iron is now easily available at \$50. Basic iron late in June sold at \$53, valley, and there were reports of business at \$54 being done, but in the closing days of August a sale of 5000 tons for nearby delivery was made at \$48. Further declines would undoubtedly be recorded if there were enough buying to develop fresh market prices. Basic iron has declined in the East, but foundry iron in all districts is practically unchanged, quotations having simply become nominal. The furnaces are well sold up and know they could not secure much additional business even by large cuts.

#### FINISHED STEEL PRICES

At this writing the expectations entertained for weeks that the Government would name the prices it intends to pay for finished steel products are more definite, and an announcement may have been made before this report sees the light. Even this announcement will not set the market going, as there is little probability that such prices will set the standard for the general trade.

#### PRODUCTION STATISTICS

The Geological Survey presents final figures of coke production in 1916, closely conforming to the preliminary estimates made at the beginning of the year. The production of beehive coke was 35,464,224 short tons, performing the unexpected feat of breaking by 300,000 tons the previous record, made in 1907. By-product coke production amounted to 19,069,261 tons, against 14,072,895 tons in 1915, the previous record. This made the total for 1916 54,533,585 tons. The recently issued statistical report of the American Iron and Steel Institute gives the consumption of coke by (iron) blast furnaces at 44,431,905 tons, this being 81 per cent of



the total production, not including gas-house coke, which is not reported.

The production of iron ore in 1916 is reported by the Survey at 63,735,088 gross tons by the Lake Superior region and 11,432,584 tons by all other districts, making a total of 75,167,672 tons, against a previous record of 61,980,437 tons, made in 1913. The shipments in 1916 were 77,870,553 tons, representing a reduction in stocks at mines of 2,702,881 tons.

### Chemical Market

**COAL TAR PRODUCTS.**—The situation covering products under this heading has been very quiet and uninteresting during the past two weeks and trading has been confined principally to orders for immediate or near-by needs. The trade is awaiting developments which may arise from purchases on the part of the government.

**Benzol.**—There has been comparatively little business passing in benzol during the interval. Dye manufacturers have been rather well covered by contracts and activity was confined to filling-in orders. Prices remain unchanged. So far no government business of importance has materialized.

**Dinitrochlorbenzol.**—This market has been established on a lower basis as a result of keen competition and increased production.

**Aniline Oil and Salts.**—Both of these markets have ruled easier. There has been little export demand for aniline oil, and while the production of salts continues light the demand has been limited.

**Paranitraniline.**—Contract prices have been lowered in the face of a restricted consuming inquiry and a large production. The situation is not entirely satisfactory from a manufacturer's viewpoint.

**Monochlorbenzol.**—The production appears to be increasing in a large way, and this coupled with a light export inquiry tends to create a weak market.

**Toluol.**—In contrast to the benzol situation, toluol has remained tight and there has been considerable business passing for prompt and near-by delivery. Contracts, however, have been limited owing to the uncertainty prevailing in regard to the possible purchases of the government.

**Toluidines.**—*Para* has been strong and advancing steadily. The *ortho*, however, has been neglected with supplies accumulating. *Ortho nitro toluol* has been rather easy. Manufacturers of *para nitro toluol* have experienced difficulties in their plants which so far have not been overcome.

**Naphthalene.**—The market has remained steady, but prospects do not appear particularly bright. Nitro and dinitro naphthalene prices remain unchanged with prices quiet.

**Phenol.**—In contrast to some months ago the market has remained strong and slightly higher. The outlook appears brighter than for some time.

**Diphenylamine.**—Prices have been higher owing to the very limited supplies available. Dinitrophenol prices have been lower owing to the heavier production and keen competition.

**Xylol.**—There has been much business transpiring. Both the commercial and the pure grades are lower.

**Solvent Naphthas.**—Contracts have been offered at lower prices and there seems to be sufficient material on hand to answer the requirements of the trade.

**HEAVY CHEMICALS.**—Considerable stimulus has been given to the general situation by the increasing strength in caustic soda and soda ash and other fundamental chemicals. The bichromates, both soda and potash, have increased steadily almost every day during the interval, and such items in light supply as yellow prussiate of potash and yellow prussiate of soda have also advanced. War orders have taken large quantities of caustic soda, heavy acids and ammoniates, and prices have tended upward for all these raw materials.

**Caustic Soda.**—While speculation has been partly instrumental in making for a widespread demand, the heavy consuming requirements together with the fact that most large producers are obligated for most of their spot and future production, have been the fundamental reasons for the tightening market.

**Soda Ash.**—This market has shown considerable strength both for near-by delivery and all future positions. Exports to the Orient especially are heavy, and considerable quantities are going from the West Coast; consuming demand here is also strong, and the makers are sold up. The market is in the hands of resellers.

**Bleach.**—Nothing of importance has occurred; a fairly steady tone is noted, and although the undertone is gradually increasing as the weather becomes cooler, prices for either domestic drums or export containers have not advanced much.

**Arsenic.**—No particular strength is shown in this market, and prices for future positions have shown a slight settling.

### General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET SEPT. 6, 1917

Acetic anhydride, .....	lb.	1.90	—	2.00
Acetone, drums, .....	lb.	.35	—	.36
Acid, acetic, 28 per cent, .....	lb.	.05½	—	.06
Acetic, 56 per cent, .....	lb.	.10½	—	.11
Acetic, glacial, 99½ per cent, carboys, .....	lb.	.36	—	.37
Boric, crystals, .....	lb.	.13	—	.13½
Citric, crystals, .....	lb.	.71	—	.73
Hydrochloric, commercial, 18 deg, .....	lb.	.01½	—	.01¾
Hydrochloric, 20 deg, .....	lb.	.01¾	—	.01¾
Hydrochloric, C.P., conc., 22 deg, .....	lb.	.01¾	—	.02
Hydrofluoric, 30 per cent, in barrels, .....	lb.	.05	—	.05½
Lactic, 44 per cent, .....	lb.	.11	—	.12
Lactic, 22 per cent, .....	lb.	.04½	—	.05
Nitric, 36 deg, .....	lb.	.06¾	—	.07
Nitric, 42 deg, .....	lb.	.07¾	—	.08
Oxalic, crystals, .....	lb.	.46	—	.47
Phosphoric, 85 per cent, .....	lb.	.35	—	.39
Picric, .....	lb.	.70	—	.75
Pyrogallol, resublimed, .....	lb.	3.20	—	3.30
Sulphuric, 60 deg, .....	ton	27.00	—	30.00
Sulphuric, 66 deg, .....	ton	34.00	—	35.00
Sulphuric, oleum (Fuming), tank cars, .....	ton	40.00	—	45.00
Tannic, U. S. P., bulk, .....	lb.	1.35	—	1.40
Tartaric, crystals, .....	lb.	.50	—	.81
Alcohol, grain, 188 proof, .....	gal.	4.50	—	4.35
Alcohol, wood, 95 per cent, .....	gal.	1.00	—	1.02
Alcohol, denatured, 180 proof, .....	gal.	1.00	—	1.02
Alum, ammonia lump, .....	lb.	.04½	—	.04½
Alum, chrome ammonium, .....	lb.	.18½	—	.19
Alum, chrome potassium, .....	lb.	.32	—	.34
Alum, chrome sodium, .....	lb.	.12½	—	.13
Alum, potash lump, .....	lb.	.08½	—	.09
Aluminium sulphate, technical, .....	lb.	.02	—	.02½
Aluminium sulphate, iron free, .....	lb.	.03½	—	.03½
Ammonia aqua, 26 deg, carboys, .....	lb.	.12	—	.13
Ammonium carbonate, .....	lb.	.11½	—	.13
Ammonium nitrate, .....	lb.	.22	—	.24
Ammonium sulphate domestic, .....	lb.	.07½	—	.07½
Amyl acetate, .....	gal.	4.50	—	4.60
Arsenic, white, .....	lb.	.16	—	.16½
Arsenic, red, .....	lb.	.60	—	.65
Barium carbonate, 99 per cent, .....	ton	75.00	—	—
Barium carbonate 97-98 per cent, .....	ton	65.00	—	—
Barium chloride, .....	ton	85.00	—	90.00
Barium sulphate (Blanc Fixe, powder), .....	lb.	.04	—	.04½
Barium nitrate, .....	lb.	.11½	—	.12
Barium peroxide, basis 70 per cent, .....	lb.	.27	—	.27½
Bleaching powder, 35 per cent chlorine, .....	lb.	.02	—	.02½
Borax, crystals, sacks, .....	lb.	.08	—	.08½
Brimstone, crude, .....	ton	60.00	—	65.00
Bromine, technical, .....	lb.	.70	—	.80
Calcium, acetate, crude, .....	lb.	.03	—	.03½
Calcium, carbide, .....	ton	.08	—	.09
Calcium chloride, 70-75 per cent, fused, lump, .....	ton	36.00	—	38.00
Calcium peroxide, .....	lb.	1.60	—	1.70
Calcium phosphate, .....	lb.	.30	—	.31
Calcium sulphate, .....	lb.	.01½	—	.02
Carbon bisulphide, .....	lb.	.07½	—	.08
Carbon tetrachloride, drums, .....	lb.	.16½	—	.16½



Caustic potash, 88-92 per cent.	lb.	.85	.87
Caustic soda, 76 per cent.	lb.	.09 $\frac{1}{2}$	.09 $\frac{3}{4}$
Chlorine, liquid	lb.	.15	.40
Cobalt oxide	lb.	1.40	1.50
Copperas	100 lb.	1.00	1.05
Copper carbonate	lb.	.42 $\frac{1}{2}$	.45
Copper cyanide	lb.	.75	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09 $\frac{1}{2}$	.09 $\frac{1}{2}$
Cream of tartar, crystals	lb.	.48	.49
Epsom salt, bags	100 lb.	4.15	4.25
Formaldehyde, 40 per cent.	lb.	.16	.16 $\frac{1}{2}$
Glauber's salt	100 lb.	.80	.85
Glycerine, bulk, C. P.	lb.	.64	.66
Iodine, resublimed	lb.	4.50	.....
Iron oxide	lb.	.05	.15
Lead, acetate, white crystals	lb.	.16	.17
Lead arsenate	lb.	.12 $\frac{1}{2}$	.13 $\frac{1}{2}$
Lead nitrate	lb.	.17 $\frac{1}{2}$	.18
Litharge, American	lb.	.08	.09
Lithium carbonate	lb.	1.02	1.05
Manganese dioxide, U. S. P.	lb.	.48	.55
Magnesium carbonate, tech.	lb.	.16	.16 $\frac{1}{2}$
Nickel salt, single	lb.	.11	.11 $\frac{1}{2}$
Nickel salt, double	lb.	.08	.08 $\frac{1}{2}$
Phosphorus, red	lb.	1.50	1.60
Phosphorus, yellow	lb.	2.20	2.25
Potassium bichromate	lb.	.41	.42
Potassium bromide granular	lb.	1.35	1.40
Potassium carbonate calcined, 80-85 per cent.	lb.	.70	.75
Potassium chlorate, crystals	lb.	.54	.55
Potassium cyanide, 98-99 per cent.	lb.	2.30	2.50
Potassium iodide	lb.	2.00	2.92
Potassium muriate 80-85 p.c. basis of 80 p.c.	ton	330.00	340.00
Potassium nitrate	lb.	.29	.30
Potassium permanganate	lb.	4.00	4.25
Potassium prussiate, red	lb.	2.90	3.00
Potassium prussiate, yellow	lb.	1.15	1.25
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	300.00	325.00
Rochelle salts	lb.	.39	.39 $\frac{1}{2}$
Salammoniac, gray gran.	lb.	.10 $\frac{1}{2}$	.11
Salammoniac, white gran.	lb.	.16	.16 $\frac{1}{2}$
Salt soda	100 lb.	1.20	1.25
Salt cake	100 lb.	1.10	1.15
Silver cyanide	oz.	.49 $\frac{1}{2}$	.50 $\frac{1}{2}$
Silver nitrate	oz.	4.00	4.25
Soda ash, 58 per cent, light, flat	100 lb.	4.00	4.15
Soda ash, 58 per cent, dense, flat	100 lb.	4.00	4.15
Sodium acetate	lb.	.10 $\frac{1}{2}$	.11
Sodium benzoate	lb.	2.25	2.50
Sodium bicarbonate, domestic	100 lb.	2.25	2.50
Sodium bicarbonate, English	lb.	.23	.24
Sodium bichromate	lb.	.04	.04 $\frac{1}{2}$
Sodium bisulphite, powd.	lb.	.24	.25
Sodium chlorate	lb.	.54	.55
Sodium cyanide	lb.	.18	.18 $\frac{1}{2}$
Sodium fluoride, commercial	lb.	.01 $\frac{1}{2}$	.02
Sodium hyposulphite	lb.	4.40	4.45
Sodium nitrate, 95%	100 lb.	.45	.50
Sodium nitrite	lb.	.75	.80
Sodium peroxide	lb.	.04 $\frac{1}{2}$	.05
Sodium phosphate (tri.)	lb.	.32	.33
Sodium prussiate, yellow	lb.	2.50	2.60
Sodium silicate, liquid—40 deg. Baumé	100 lb.	3.00	3.10
Sodium sulphide, 30 per cent crystals	100 lb.	4.50	4.55
Sodium sulphide, 60 per cent, fused	lb.	.04	.05 $\frac{1}{2}$
Sodium sulphite	lb.	.28	.30
Strontium nitrate	lb.	.06	.06 $\frac{1}{2}$
Sulphur chloride, drums	lb.	.15	.40
Sulphur dioxide, liquid, in cylinders	100 lb.	3.95	4.00
Sulphur, flowers, sublimed	100 lb.	3.70	3.85
Sulphur, roll	100 lb.	60.00	65.00
Sulphur, crude	ton	.19 $\frac{1}{2}$	.20
Tin bichloride, 50 deg.	lb.	.64 $\frac{1}{2}$	.65
Tin oxide	lb.	.25	.27
Zinc carbonate	lb.	.10 $\frac{1}{2}$	.11
Zinc chloride	lb.	.50	.50
Zinc cyanide	lb.	.17	.19
Zinc dust 350 mesh	lb.	.15 $\frac{1}{2}$	.16
Zinc oxide, American process XX	lb.	.05 $\frac{1}{2}$	.06
Zinc sulphate	lb.	.....	.....

## Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.50	.52
Benzol, 90 per cent.	gal.	.50	.52
Toluol, pure water white	gal.	1.75	1.80
Xylol, pure, water white	gal.	.45	.50
Solvent naphtha, water white	gal.	.18	.22
Solvent naphtha, crude, heavy	gal.	.13	.16
Cresote oil, 25 per cent.	gal.	.31	.33
Dip oil, 20 per cent.	gal.	.29	.30
Pitch, various grades	ton	8.00	20.00
Carbolic acid, crude, 95-97 per cent.	lb.	1.00	1.05
Carbolic acid, crude, 50 per cent.	lb.	.55	.60
Carbolic acid, crude, 25 per cent.	lb.	.32	.35
Cresol, U. S. P.	lb.	.25	.....

## Intermediates, Etc.

Alpha naphthylamin	lb.	.70	.75
Aniline oil	lb.	.27	.28
Aniline salts	lb.	.33	.34
Anthracene, 80 per cent.	lb.	.10	.....
Benzaldehyde	lb.	4.00	4.50
Benzidine, base	lb.	1.85	1.90
Benzidine, sulphate	lb.	1.50	1.55
Benzoic acid	lb.	2.25	2.50
Benzyl chloride	lb.	1.75	2.00
Beta naphthol benzoate	lb.	8.00	8.50
Beta naphthol, sublimed	lb.	.85	.90
Beta naphthylamin com.	lb.	2.50	.....
Dichlor benzol	lb.	.12	.18
Dinitrochlorbenzol	lb.	.44	.46
Dimethylaniline	lb.	.58	.60
Diphenylamine	lb.	1.00	1.10
H-acid	lb.	3.00	3.50
Metaphenylenediamine	lb.	1.75	1.80
Monochlorbenzol	lb.	.22	.23
Naphthalene, flake	lb.	.09	.09 $\frac{1}{2}$
Naphthalene, crude	lb.	1.50	1.75
Nitro naphthalene	lb.	.45	.50
Nitro toluol	lb.	.50	.55

Ortho-amidophenol	lb.	.....	.....
Ortho-toluidine	lb.	.90	1.00
Para-amidophenol, base	lb.	4.00	5.00
Paranitraniline	lb.	1.05	1.10
Paraphenylenediamine	lb.	3.50	4.00
Para toluidine	lb.	2.00	2.10
Phenol, U. S. P.	lb.	.42	.43
Resorcin, technical	lb.	8.00	9.00
Resorcin, pure	lb.	13.50	15.00
Salicylic acid	lb.	1.40	1.50
Salol	lb.	1.85	2.00
Sulphanilic acid	lb.	.32	.35
Tolidin	lb.	3.00	.....
Toluidine-mixture	lb.	.75	.85

## Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbbl.	3.50	.....
Corning, Ohio	bbbl.	2.60	.....
Somerset, Ky.	bbbl.	2.40	.....
Wooster, Ohio	bbbl.	2.38	.....
Indiana	bbbl.	1.98	.....
Illinois	bbbl.	2.12	.....
Oklahoma and Kansas	bbbl.	2.00	.....
Caddo, La., light	bbbl.	2.00	.....
Corsicana, Tex., light	bbbl.	2.00	.....
California	bbbl.	.98	1.32
Gulf Coast	bbbl.	1.00	.....

## Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	13 $\frac{1}{2}$	14
Cylinder, light	gal.	21	26
Cylinder, dark	gal.	18	19
Paraffine, high viscosity	gal.	29 $\frac{1}{2}$	30
Paraffine, .903 sp. gr.	gal.	21 $\frac{1}{2}$	22
Paraffine, .865 sp. gr.	gal.	18 $\frac{1}{2}$	19

## Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	.....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	.53
Pine tar oil, sp. gr. 1.025-1.035	gal.	.25 $\frac{1}{2}$	.....
Pine tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	.....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	.....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	.....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	.....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	.....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	.....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	.....
Wood creosote, ref.	gal.	.50 $\frac{1}{2}$	.....

## Vegetable and Other Oils

China wood oil	lb.	19 $\frac{1}{2}$	20
Cottonseed oil, crude	gal.	1.02	.....
Linseed oil, raw, cars	gal.	1.24	.....
Peanut oil, crude	gal.	1.17	1.20
Rosin oil, first run	gal.	.35	.....
Rosin oil, fourth run	gal.	.66	.....
Soya bean oil, Manchuria	lb.	.14	14 $\frac{1}{2}$
Turpentine, spirits	gal.	.42	.....

## Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	40.00
Barytes, floated, white, domestic	ton	28.00	32.00
Beeswax, white, pure	lb.	.65	.68
Carnauba wax, flor.	lb.	.53	.....
Caslin	lb.	.22	.30
Chalk, light, precipitated, English	lb.	.03	.06
Feldspar	ton	8.00	12.00
Fuller's earth, powdered	100 lb.	1.00	1.50
Osokerite, crude, brown	lb.	.60	.70
Osokerite, American, refined, white	lb.	.75	1.00
Red lead, dry, carloads	lb.	.13	.....
Rosin, 280 lb.	bbbl.	6.00	.....
Soapstone	ton	10.00	12.50
Talc, American, white	ton	10.00	13.00
White lead, dry	lb.	.11 $\frac{1}{2}$	.....

## Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal	Nominal
Chrome cement, Grecian	net ton	50.00	55.00
Clay brick 1st quality fireclay	per 1000	35.00	40.00
Clay brick, second quality	per 1000	30.00	35.00
Magnetite, raw	ton	40.00	55.00
Magnetite, calcined	ton	85.00	90.00
Magnetite, Grecian, dead burned	net ton	135.00	140.00
Magnesia brick, Grecian, 9x4 $\frac{1}{2}$ x2 $\frac{1}{2}$	per 1000	50.00	60.00
Silica brick	per 1000	50.00	60.00

## Ferroalloys

Ferrocarbondititanium, 15-18 per cent, carloads, f.o.b.	ton	160.00	.....
Niagara Falls, N. Y.	ton	.20	.....
Ferromanganese, domestic, delivered	ton	375.00	400.00
Ferromanganese, English	ton	375.00	.....
Ferromolybdenum, per lb. of Mo.	lb.	4.00	4.40
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	225.00	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.60	2.65
Ferroumium, f.o.b. works, per lb. of U.	lb.	7.00	.....
Ferrovanadium, f.o.b. works	lb.	3.25	3.50

## Ores and Semi-finished Products

Chrome ore, 46 per cent minimum, f.o.b. Cal., per unit	ton	.90	.....
Manganese ore, 48 per cent and over, per unit	ton	1.00	.....
Molybdenite, per lb. of MoS <sub>2</sub>	lb.	2.10	.....
Tungsten, Scheelite, per unit of WO <sub>3</sub>	ton	25.00	.....
Tungsten, Wolframite, per unit of WO <sub>3</sub>	ton	24.00	.....
Uranium oxide, 96%	lb.	3.25	3.50
Vanadium Pentoxide, 99%	lb.	11.00	.....

# INDUSTRIAL

## Financial, Construction and Manufacturers' News

### Financial

#### New Companies

The Advance Caulking Company, Chicago, Ill., has been incorporated in Delaware with a capital of \$15,000 to manufacture caulking materials, etc. S. M. Paulsen, F. A. Bennett and W. L. Topper, Chicago, are the incorporators.

Aircraft Fireproofing Corporation, Wilmington, Del.; manufacture of chemicals, dyes, paints, etc.; capital, \$600,000.

The Albamont Chemical Company, St. Louis, Mo., has filed articles of incorporation in Delaware with a capital of \$100,000 to manufacture special chemical products. The incorporators are: William P. and A. White, and C. B. R. FitzWilliams, all of St. Louis.

American-Italian Commercial Corp., Dover, Del., \$2,000,000.

The American Shell Company, New York, has been incorporated in Delaware with a capital of \$2,000,000 to manufacture shells, castings, and kindred metal products. A. W. Britton, H. O. Coughlan, and Samuel B. Howard, 65 Cedar Street, New York, are the incorporators.

The Angola Tire & Rubber Company, Inc., Buffalo, N. Y., has filed articles of incorporation with a capital of \$1,000,000 to manufacture rubber goods of various kinds. F. M. Wood, M. M. Levy and S. C. Kelly, all of Buffalo, are the incorporators.

Cable Chemicals Co., Cable, Ill., \$5,000; W. C. Hibbert, A. E. Malone, Walter Rosenber, incorporators.

Carbon Products Co., Wilmington, Del., to contract, separate, treat and refine wax, tar, dyes, etc. J. G. Gray, M. B. F. Hawkins and H. M. Kennedy, incorporators.

Carlisle Cotton Oil Company, Carlisle, S. C., capital \$20,000; incorporated. J. E. Lipscomb, president; M. C. Deaverfi, vice-president, and W. H. Gist, secretary-treasurer.

Carolance Co. of America, Inc., New York City, \$80,000. To manufacture dye stuffs, chemicals and drugs. Incorporators are M. Brusie, R. R. Robins and J. T. Crane.

Catchpole Foundry Corp., New York, \$50,000. To build general foundry and machine shop. Walter Howard, A. G. Lewis and C. Willard Rice, incorporators.

Central Oil Burner Corp., Wilmington, Del., \$160,000. To buy and sell a rotary burner.

Geo. W. Chapman & Co., Inc., New York City, \$10,000. To manufacture paper, machine, and general construction business. G. W. Chapman, W. and W. P. Barker, incorporators.

The Chemical Corporation of New Jersey, Newark, N. J., has been incorporated with a capital of \$25,000 to manufacture chemicals. S. Dowling, N. R. Crum and C. F. Crum, Newark, are the incorporators.

DeSoto Paint Mfg. Co., Memphis, Tenn., \$100,000. Thos. F. Lillu, R. L. Defries and S. T. Carnes, incorporators.

The Foraythe Chemical Corp., Cleveland, O., \$50,000. Incorporators, E. P. Dowling, J. L. Dowling, R. J. Moriarty, C. D. Ainger and P. B. Condit.

The Glen Rock Oil Company, New York, has been incorporated in Delaware with a capital of \$20,000,000. The company will comprise a merger of the Glen Rock Petroleum Company, the Hall Oil Company, the Pilot Butte Oil Company and the Superior Oil Company. The last noted company maintains offices at 29 Lewis Street.

Goodrich-Lockhart Co., Orange, N. J., \$250,000. To make and sell chemicals. Incorporators, E. J. McWhinney, W. J. Maloney and N. P. Coffin, Wilmington, Del.

Kootenay Silver Mines, Inc., Wilmington, Del. Capital, \$1,000,000.

Marden, Orth & Hastings Corp., New York City, \$1,950,000. To import and export oils, chemicals and dyestuffs. M. S. Orth, A. F. Burnham and E. N. Berkins incorporators.

The Marshall-Haley Mica Company, Philadelphia, Pa., has been incorporated with a capital of \$10,000 to operate a plant for

the production of mica and allied specialties. C. C. Bond, Ashbourn, heads the company.

Mogul Tires, Inc., Pearl River, N. Y., has been incorporated in Delaware with a capital of \$2,500,000 to manufacture automobile tires and other rubber goods. Arthur R. Oakley, Pearl River; Richard A. Webster, New York, and W. E. Shields, Jr., Brooklyn, are the incorporators.

The Palmer Rubber Company, Poughkeepsie, N. Y., has filed articles of incorporation with a capital of \$10,000 to manufacture automobile tires and other rubber goods. E. I. Dusenbury, J. F. MacDonald and F. D. Palmer, all of Poughkeepsie, are the incorporators.

Paper Products Machine Co., Boston, Mass., \$50,000. P. T. Jackson, Jr., and Chas. H. Howard, incorporators.

Pennsylvania Explosives Co., New York City, \$10,000. To manufacture blasting powder, explosives and chemicals. A. and S. T. Stern, incorporators.

Pensacola Fertilizer and Oil Co., New York City, \$250,000. M. McGrath, L. Kallman and F. W. Miller, incorporators.

Perfenol Company, Elizabeth, N. J.; to manufacture synthetic products; \$50,000. H. F. Ratigan, K. C. Fitz Simmons and R. T. Green, all of Paterson.

The Pneumatic Acetylene Generator Corp., New York City, J. G. Redmond, Chas. V. Kiernan and Otto Faeltin, incorporators.

The Publishers Paper Co., Inc., New York City, \$85,000. To manufacture paper and paper products. Incorporators are F. P. Sherwood, J. W. Burg, T. J. Walsh, incorporators.

Robinson Paint Company, Aurora, Ill., capital, \$74,000. Incorporators, Harvey Musser, Harvey Gunsul, Olney Allen.

Harry V. Roeder, Inc., New York, has been incorporated with a nominal capital of \$8,000 to manufacture chemicals and allied products. J. Edwards and O. R. and H. R. Roeder, 68 West Ninetieth Street, New York, are the incorporators.

The St. Louis Foundry & Manufacturing Company has been taken over by Orville Allen, J. I. McCormick and C. L. Graham of Alma, who will reorganize it with a capitalization of \$50,000 and change its name to the Gratiot Foundry Co.

The Sheffield Iron Corporation, New York, has filed articles of incorporation with a capital of \$777,500 to manufacture steel, iron and other metal products. J. R. Floyd, J. Gayley and H. K. Wood, 65 Cedar Street, New York City, are the incorporators.

Staler Chemical Company, Newark, N. J., to make and deal in chemicals of all kinds; \$50,000. H. Staler and J. C. Staler, both of New York, and F. W. Miller, Newark.

The Standard Sulphur Corporation, Dover, Del., has filed articles of incorporation with a capital of \$6,200,000 to operate a plant for the production of sulphur and kindred products. The incorporators are George G. Stiegler, W. F. O'Keefe and M. Gehrman, Wilmington.

The Sterizol Co., Fostoria, N. Y., \$250,000. W. R. Baker, G. D. Baker, M. F. Jacus, B. Emmert, R. Kleinhen. To manufacture chemicals.

Stubner Chemical Works, Inc., Philadelphia, Pa., \$100,000. To manufacture dyes and chemicals and alkalies. M. M. Clancy, Clement M. Egner, incorporators.

The Summit Mining & Milling Company, Wallace, Idaho, has filed articles of incorporation with a capital of \$200,000. C. H. McLean, W. H. Robinson and J. H. McEvers, incorporators.

The Superior Copper Mine & Development Company, Vancouver, Wash., has been incorporated to develop copper mines in Skamania County. Company maintains head offices in the Couch Building, Portland, Ore.

The Synthetic Color & Chemical Company, Inc., Los Angeles, Cal., has been incorporated with a capital of \$25,000 to manufacture chemicals and allied products. J. F. Long, Anton Dahl and M. A. Evans,

Los Angeles, and B. A. Stiles and H. W. Schroeder, Glendale, Cal., are the incorporators.

United Ohio and Chemical Corporation; to deal in and with oils, greases, tars, chemicals, etc.; \$2,000,000. F. A. Armstrong, C. M. Egner, W. S. Randall, Wilmington, Del.

The Vacuum Refrigeration Company, Philadelphia, Pa., has been incorporated under Delaware laws with a capital of \$750,000, to manufacture refrigeration apparatus and kindred specialties. G. H. V. Martin, Philadelphia; S. C. Seymour and J. V. Pimm, Camden, N. J., are the incorporators.

The Watkins Tubeless Air-Cooled Auto Tire Company, Pittsburgh, Pa., has filed articles of incorporation under Delaware laws with a capital of \$1,000,000 to manufacture automobile tires and kindred products. W. Burnside, Pittsburgh; T. C. Watkins, Ingram, Pa., and Morgan Howells, Orville, Ohio, are the incorporators.

The Watson Suspension Wheel & Rim Corporation, Dover, Del., has been incorporated with a capital of \$1,000,000 to acquire and operate the plant of the Watson Suspension Wheel Company. M. H. Morris, A. M. Halloran and S. A. Williams, Wilmington, are the incorporators.

Western Alkali Refining Company, Wilmington, Del.; \$2,000,000; to make alkali and chemicals.

### Company Reports

The annual report of the AMERICAN AGRICULTURAL CHEMICAL COMPANY for the fiscal year ended June 30, issued recently, shows net profits of \$5,546,355, an increase of \$100,828 over the previous year. After the payment of dividends on the preferred amounting to \$1,655,067, there was a balance of \$3,891,288 available for the \$18,430,900 common stock, an increase of \$99,258 over the previous twelve months. This is equivalent to \$21.11 a share on the common compared with \$20.50 a year ago.

In his remarks to stockholders, President Peter B. Bradley says:

"With a rigid embargo placed on potash salts by the German Government early in the war, prices for potash rose over 100 per cent, nitrate of soda and sulphuric acid appreciated from 100 per cent to 300 per cent, while fuel, labor, machinery and other supplies rose to new levels. As a result, the whole industry became disorganized, necessitating a radical readjustment of prices to the higher costs of production, as well as many changes in the composition of mixed fertilizers, especially as to their content of potash, a normal supply of which was absolutely unobtainable at any price. Not only was the market for raw materials abnormal, but it was extremely unstable as well, making it difficult and even hazardous to name prices on manufactured products for future delivery.

"The past fiscal year has brought no relief to these exceptional conditions, but the enormous demand for food crops and cotton, brought about by the exigencies of war, has greatly stimulated the demand for fertilizers, so that there was no difficulty in selling all the manufactured fertilizers which were available last spring, though a still further rise in prices of raw materials, freights, insurance, etc., found the company's selling prices toward the end of the season out of line with the cost of production."

In the annual report of the VIRGINIA-CAROLINA CHEMICAL COMPANY recently issued, President S. T. Morgan remarks that the fertilizer consumption this year materially increased throughout the South, as a reflex of the poor cotton crop of the previous year, farmers learning thereby to fertilize much more liberally this year, with consequent increased business for the company and increased crops for themselves.

"The demand for fertilizers for the fall seeding of wheat is probably as large as, if not larger than, we have ever known it," the report says. "Every indication points to a consumption fully up to, if not more than equal to the supply. The prices will necessarily be high in comparison with previous years. The foreign exports by this company and its subsidiary companies, for some months past, have been largely cut off. Fortunately the domestic demand has been such as to enable us to take care of the business in a fairly satisfactory manner."

The business done during the year was the largest in the history of the company, amounting to \$83,774,580, but much of this was due to increased prices, and the percentage of profit was relatively small, although the net earnings were the largest, also, in the history of the company.



## Construction and Operation

### Alabama

**SHEFFIELD.**—That the Sheffield Rolling Mill plants will begin operation early in September was officially announced here recently by Armistead & Fulbright, lessees of the properties. The announcement is of great import to the people of Sheffield and coming just at this time with work already started at the iron furnaces of the Sheffield Coal & Iron Co., a feeling of genuine satisfaction and optimism prevails. Skilled labor of the highest type is employed in rolling mill work and the pay roll of the mill when it is in operation will amount to more than \$30,000 monthly. Coincident with the rolling mill announcement to-day further interest is aroused locally by the presence of Warren L. Klutz, recently appointed general manager of the Sheffield Coal & Iron Co., who arrived here yesterday to assume this official duty in control of the operation of the company's local plants, being accompanied by F. B. McKensie of Tuscaloosa, who will become superintendent of furnaces, and J. M. Coshier of Birmingham, who it is stated will be connected with the company.

**UNION SPRINGS.**—The Southern Cotton Oil Company is now spending about \$3,000 on the mill at this place in order to make the necessary changes for crushing peanuts and to modernize the mill for the crushing of cotton seed, according to I. M. Bryan, manager of the local plant. Mr. Bryan thinks the machinery will be in place and other changes made by Sept. 15, or by the time the crops begin to move.

### California

**LOS ANGELES.**—Dwight Whiting, a young business man of Los Angeles and a member of one of California's oldest families, has pledged his personal fortune toward building an explosives plant. The new concern will be called the Whiting Powder Works. It will occupy a large tract of waste land and it will have an equipment sufficient to handle large Government orders.

**SAN FRANCISCO.**—Plans are being prepared for a \$100,000 building project at Moss Landing, Monterey County, for the recently incorporated California Sea Products Company, by Architect Henry Schultz on seven acres of land there that have been purchased by the company. Its purpose is to catch whales and utilize all of the leviathan's parts—the bone, much of the carcass for fertilizer, the skin for leather and choice parts of the flesh as whale steaks for consumption in the city and state.

**SAN FRANCISCO.**—Construction of one of the largest factory buildings on the Coast is nearing completion at Eighth and Brannan Streets, where the National Carbon Company is establishing its Pacific Coast plant. The building was to be finished and occupied Sept. 1. Announcement was made recently that the company is preparing plans for a complete factory building adjoining the new structure, of which it will be an exact duplicate. The present structure is reported to have cost \$500,000 and the proposed factory will represent an investment of a larger sum. The factory building has more than six acres of floor space. It is four stories high, with a high basement. The frontage on Brannan Street is 187 ft. and on Eighth Street 400 ft. Of reinforced concrete, the building represents the latest type of factory construction, having a complete concrete frame with monolithic floors and roof and practically all the exterior walls of steel frame windows and wire glass. The fronts are faced with terra cotta. Spur tracks connect the factory with the railroads. Five elevators will be used in the building, also two spiral chutes, a vacuum tube system, vacuum cleaning plant, intercommunicating telephones, modern heating and ventilating systems and similar equipment.

### Connecticut

**NAUGATUCK.**—The Goodyear Metallic Rubber Shoe Company has commenced the construction of a new five-story plant, about 55 x 125 ft. Lockwood, Greene & Company, 60 Federal Street, Boston, Mass., are engineers.

**STAMFORD.**—The Stamford Rolling Mills has commenced the construction of a one-story addition to its plant, about 60 x 75 ft.

### Delaware

**WILMINGTON.**—The Tabor-Davidson Company has filed notice of change in its company name to the Die Cast Fiber Company.

**NEW CASTLE.**—A portion of the plant of the Bethlehem Steel Company was destroyed by fire Aug. 14, with loss estimated at about \$30,000. It is said that the loss will be immediately replaced.

### Florida

**JACKSONVILLE.**—The Virginia-Carolina Chemical Co. has succeeded in securing from the City Commission a long time lease on certain property on the waterfront which will be used in establishing a permanent building for the manufacture of fertilizer products. The corporation is one of the largest in the business and it is announced that when the plant is completed and put in full motion it will employ not less than 400 men. Jacksonville has developed considerably as a fertilizer center. Some of the largest plants in the South are already located here.

### Idaho

**MOSCOW.**—A directory of mining properties in Idaho is being prepared by Prof. E. K. Soper and Prof. D. C. Livingston. The Legislature, at its last session, appropriated \$4,000 for this purpose.

### Illinois

**CHICAGO.**—John Miller & Sons, jobbers in leather and dealers in hides, have purchased the malthouse property on the Chicago River at Clybourn Place and the intersection of the St. Paul Railroad for \$125,000, on which they will construct a tannery to cost probably \$300,000. It is said that it will be one of the largest and best equipped plants in the country. This is a new tannery, the projectors not having been engaged in the tanning business before.

**EAST ST. LOUIS.**—The formal opening of the new \$1,000,000 tannery of the International Shoe Company was held near Woodrider recently. Three hundred and fifty salesmen and officials of the company from all over the country came in seven special cars to view the plant. The plant will be put in operation within three weeks. Twenty-five men will be used at the start and at the end of three months 300 men will be working in the four-story brick building, which is 125 x 623 ft. One-sixth of the leather to be used by the International Shoe Company will be turned out at this plant.

**EAST ST. LOUIS.**—Location of a potash plant in the eastern part of the Washington Park industrial district is contemplated by the Alunite Company of America, with headquarters in Kansas City. The president is Thomas Twing, a prominent oil operator. The raw material will be transported from Colorado to East St. Louis.

### Indiana

**TERRE HAUTE.**—The Midland Electric Steel Company, recently incorporated, will put in operation early in October a 1200-kva., 3-ton holding capacity, two-phase, Booth-Hall electric steel furnace, capable of turning out 30 tons of steel per 24 hours, melting and refining cold scrap. The plant will be located at Terre Haute, Ind., in connection with the Highland Iron & Steel Company, an arrangement having been made for the latter company to roll the product, which will be forging billets 4 in. square and under. Mr. Joseph B. Moos, 116 South Michigan Avenue, Chicago, is president of the Midland Electric Steel Company. The directors are Mr. Moos, Mr. W. C. Ely, treasurer and general manager of the Highland Iron & Steel Company, and Mr. Moses E. Greenebaum, president of the Greenebaum Sons Bank & Trust Company, Chicago. Power for operating the furnace will be supplied by the Terre Haute, Indianapolis & Eastern Traction Company.

### Maryland

**BALTIMORE.**—The United States Industrial Alcohol Company, New York, operating the Curtis Bay Chemical Company with plant at Stonehouse Cove, is planning for extensions and alterations in the works for the manufacture of potash. For the past twenty-four months the plant has been devoted to the production of high explosives, and necessary changes will be made to provide for the manufacture of the new product and also other by-products.

**BALTIMORE.**—The Baltimore Tube Company will build a new one-story rolling mill, about 145 x 540 ft., to cost \$96,000. Contract for construction has been awarded.

**ELKTON.**—It is probable that the big paper mill of the Jessup & Moore Company, located at Providence, five miles north of

Elkton, will be removed here. This big concern has already one of the largest pulp mills and bleaching mills in the country, located in Elkton, on the banks of the Big Elk Creek, and has excellent railroad facilities.

### Missouri

**JOPLIN.**—Another lead smelter is to be built in the Missouri-Kansas-Oklahoma district at a cost of approximately \$150,000. Although the site has not finally been chosen it will be south of the Kansas-Oklahoma line, west of Quapaw, Okla. The Ontario Smelting Company, a Delaware corporation with a paid up capital of \$250,000, is to build the plant. It will have a capacity of treating 500 tons of ore a week. Three different sites are under option by the company. C. V. Jones of Joplin is president and treasurer of the company.

### Montana

**COOKE CITY.**—Dr. G. L. Tanzler of Seattle announces that the Cooke Smelter at Cooke City, completed last year, will be operated as soon as the company receives a permit from the Government to operate cars through the Yellowstone Park.

**GREAT FALLS.**—After an inspection of the local properties of the Anaconda Copper Mining Company, Chairman A. F. Spriggs of the Industrial Insurance Commission announced that safety appliances in both the B. & M. smelter and the big plants of the Montana Power Company are minimizing accidents to a large extent.

### New Jersey

**BOONTON.**—The Knox Hat Company, Inc., has sold the factory which it formerly occupied at Boonton, N. J. The property consists of about five acres, with brick buildings, a private artesian well water supply and a railroad siding. The buyer, Stevenson & Co., a new firm, will use the factory for refining coconut oil into edible products.

**CAMDEN.**—The Wilkes, Martin, Wilkes Company, manufacturer of lampblack and allied specialties, is taking bids for the construction of a two-story addition to its plant, about 80 x 100 ft., on Pine Street.

**HARRISON.**—In order to provide for its steadily-growing business the Riverside Steel Casting Company will build a large extension to its foundry at the works on Passaic Avenue in the southern end of Kearny near Lincoln Highway.

**JERSEY CITY.**—The Seydell Manufacturing Company, 88 Forest Street, manufacturer of chemicals, is reported to be planning for the rebuilding of its plant recently destroyed by fire. Paul Seydell, president.

**NEWARK.**—The Butterworth-Judson Company, manufacturer of chemicals, has commenced the erection of several additions to its plant on Avenue R. The work will comprise a two-story factory, about 21 x 120 ft., to cost \$20,000, and two condensing gas towers to cost \$65,000.

**NEWARK.**—The Colt Machine & Engineering Company has awarded contracts for the construction of a new machine works on Colt Street, Irvington, to cost about \$21,100. Charles Flocken, Newark, has the contract for erection.

**NEWARK.**—The Union Smelting & Refining Company has commenced the erection of a one-story brick addition to its plant, about 65 x 100 ft., on St. Charles Street, to cost about \$20,000.

**NEWARK.**—The Hanson & Van Winkle Company, manufacturer of chemicals, will make extensions and improvements in its plant at Adams and Chestnut Streets.

**NEWARK.**—The F. W. Devoe & C. T. Reynolds Company, 223 New Jersey Railroad Avenue, manufacturer of paints and varnishes, has filed plans for the construction of a one-story brick addition, about 40 x 50 ft.

**PATERSON.**—The Commercial Chemical Corporation of New York, Newark and Hoboken has purchased a plot containing about twenty acres at the Boulevard and East Forty-third Street and plans will be prepared at once for the erection of a plant for the manufacture of perfumery and similar commodities.

**PERTH AMBOY.**—The American Smelting & Refining Company has commenced the erection of a new one-story tin furnace building. The structure will be about 40 x 110 ft.

**PERTH AMBOY.**—The American Encaustic & Tiling Company will build a one-story addition to its plant on State Street.

**RAHWAY.**—Merck & Company, Lincoln Avenue, manufacturers of chemicals, have awarded a contract for the construction of a one-story addition to their plant, about 40 x 56 ft.



**HARRISON.**—Reuther Brothers, Middlesex Street, operating a foundry for the production of gray iron castings, are planning for the early occupancy of their new plant now in course of construction. The new works are rapidly nearing completion, and represent an investment of about \$40,000.

**TRENTON.**—The International Fibre Company, recently incorporated, has leased the plant of the American Rubber Manufacturing Company of New Jersey on Perrine Street, for the manufacture of artificial leather under a special process. It is reported that the American Rubber Company will be consolidated with the new organization. LeRoy W. Skelton and Peter E. Wurflein head the company.

**TRENTON.**—The Delton Tire & Rubber Company has awarded contracts for the construction of a new two-story addition to its plant, about 65 x 290 ft., to cost \$95,000.

### New York

**BROOKLYN.**—The P. H. Gill Forge & Machine Company is planning for the immediate erection of a two-story addition to its works on Lorraine Street.

**BUFFALO.**—The Donner Steel Company will build a new one-story addition, about 30 x 35 ft., to its plant at 475 Abbott Road, to cost \$10,000.

**BUFFALO.**—The American Radiator Company, it is reported, has acquired property at the corner of Delaware and Hertel Avenues, joining the site of its present Pierce plant, to be used for expansion.

**BUFFALO.**—Fire recently destroyed a portion of the main plant of the N. B. Falls Lubricating Company, Manitoba Street, with loss estimated at about \$10,000. The company specializes in the manufacture of oils and greases. It is said that the plant will be immediately rebuilt.

**CARTHAGE.**—The E. R. Barker Company of Boston is installing one of their most modern acid plants and reclaiming systems in the plant of the Carthage Sulphite, Pulp & Paper Company. Floyd Hunkins, who was formerly superintendent of the Carthage Sulphite P. & F. Co., is the erecting engineer.

**CASTLETON.**—The Fort Orange Paper Company, manufacturer of cardboard, will build a new one-story addition to its plant on Oak Grove Road to cost about \$18,000.

**GOVERNEUR.**—J. H. McLeary, chairman of the Trade and Manufacturing Committee on the Gouverneur Chamber of Commerce, who has been in communication with the New Jersey Smelting Company, which contemplates locating in this village in the near future, stated that in all probability the company would start building here in the near future as they find that the water supply which they require is available here at an economical figure. He stated that at the last meeting of the chamber that the company would require 30,000 hp. eventually and that the Oswegatchie Light & Power Company of this village were in a position to furnish that amount in the near future and that the lighting company has already given the Smelting company information to that effect and although the power is not at present available it can be produced in sufficient quantities to meet their demands as they increase their plant.

**HASTINGS-ON-HUDSON.**—The plant and business of the Pan Chemical Company, recently acquired by the duPont Chemical Works, 120 Broadway, New York, is being removed to Hopewell, Va. The company is planning for increased capacity at the new location.

**NEW YORK.**—The Government of Chile has decided to expend \$3,500,000 in the improvement of Antofagasta, the principal port for the export of sodium nitrate. Chile's nitrate business has grown greatly because of the war's cutting off the German supply from other nations and also because the manufacture of munitions has increased the demand for saltpetre. One of the objects of Antofagasta improvements is to equip Chile to hold this greater nitrate business after the war is over. The Chilean Government has turned to the United States to have this work done and bids have been asked of American contractors for the construction of the waterfront improvements, as well as bids for taking up the loan the Government will make to finance the undertaking. The attention of American business men is also called to the fact that the improvement to the Port of Antofagasta is also important to the commerce of Bolivia, the port connecting with that country by the Chilean-Bolivian Railway.

**SOLVAY.**—The Semet-Solvay Company is negotiating with the Hamilton By-Product Coke Owens, Ltd., Hamilton, Ontario, for the construction of a new by-product

coke plant to cost about \$2,000,000. The works will have a daily capacity of about 900 tons of coke and 7,000,000 cu. ft. of gas.

**UNION.**—The Union Chemical Company, Inc., a company with headquarters on North Chenango Street, Binghamton, has rented the buildings of the old carriage factory on Jennings Street, Union, and has installed vats and machinery. A force of men is hired and the factory ready for operation, but the raw material necessary has not arrived.

### North Carolina

**WILMINGTON.**—The North State Pulp & Paper Company is planning for the construction of a new paper mill with daily capacity of about 100 tons. The company has recently increased its capital from \$125,000 to \$2,000,000 for the proposed extension, and a site for the mill has been acquired. W. H. Crocker is president.

### Ohio

**CANTON.**—Negotiations have practically been completed for the sale of the Canton Sheet Steel Co., a \$2,000,000 corporation, to Philadelphia interests.

**CLEVELAND.**—The Grasselli Chemical Co. has decided to enter the explosive industry. For the purpose a corporation known as The Grasselli Power Co. has been organized under the laws of Ohio, with a capital of \$3,000,000. This company will take over the properties and business of the American High Explosives Co., and the Burton Powder Co., of New Castle, Pa., and the Cameron Powder Manufacturing Co., of Emporium, Pa. The Grasselli Powder Co. is a subsidiary of the Grasselli Chemical Co. The president of the new company will be Job Burton of Pittsburgh, now president of the Burton Powder Co. J. S. Burton will be the first vice-president and general manager of the new company. T. S. Grasselli will be second vice-president. E. R. Grasselli will be treasurer and R. R. Dixon will be secretary. Additional directors will be G. E. Fisher, second vice-president, and E. W. Furst, third vice-president of the Grasselli Chemical Co. At the offices of the Grasselli Chemical Co. it was stated that manufacture of commercial explosives was so inter-related with manufacture of chemicals that this new department was a logical development for the Chemical company. The explosive industry requires for crude material sulphuric acid, nitric acid and other products which the Chemical company manufactures. The new company is not formed as a war order concern. It is an acquisition for permanent business, including among its products dynamite and the various powders used in blasting and other commercial channels.

**CLEVELAND.**—The Standard Steel Castings Co., incorporated under the laws of Ohio in 1912, with \$125,000 capitalization, has increased its capital stock to \$1,000,000. The company is engaged in the manufacture of steel castings, specializing in automobile work. The present plant is on West Seventy-third Street and the Big Four Railroad, but the growth of the business necessitates enlargement. Work will start soon on a plant on the East Side, to be devoted exclusively to manufacture of cast steel wheels for automobile trucks. The production of the miscellaneous castings will, however, continue in the present plant. The melting equipment in the new foundry will consist of two three-ton electric furnaces as well as converters. This new shop will have a capacity of 400 wheels a day, completely machined; this machine work is done in the company's machine shop. The officers of the company are: Julius F. James, president; Edwin H. James, vice-president and treasurer; and William R. McDonough, secretary and general manager. The directors in addition to the officers named above are: E. W. Moore, P. J. Morgan, M. C. Rosenfeld, R. M. Calfee, J. G. Fogg and B. C. Tucker.

**CLEVELAND.**—Erection of a large addition to the plant of the American Can Co. was announced recently following closing of a deal for nearly five acres of land fronting on Payne Avenue N. E. and the Pennsylvania railroad tracks. The deal for the land, which was one of the largest in the industrial line ever made in Cleveland, was closed through the real estate office of the J. Timendorfer Co. The land is estimated to be worth about \$200,000 and the buildings for which it will form the site are to cost in the neighborhood of \$2,000,000. Construction is to be started soon in order to take care at an early date of the growing output of the Cleveland branch of the can company.

**YOUNGSTOWN.**—The Linde Air Products Co. will open a plant in this city for the manufacture of oxygen within a short time. The new industry will be located at Jones and Brittain Streets and preparations are being made for its early operation.

### Oregon

**BEND.**—A detailed examination of the nitrate deposits of central Oregon will be made by Hoyt S. Gale, of the U. S. Geological Survey. The matter is considered significant, as it means a reconsideration of resources in this section which had previously been refused by the Government.

**EUGENE.**—A new industry, the mining of chromite, has been built up in eastern Oregon as a result of the war, according to Dr. Warren D. Smith, head of the department of Geology of the University of Oregon. About 30 tons of chromite is shipped daily from Praries City.

**PORTLAND.**—An addition to the Willamette Iron & Steel Company's plant on North Front Street will rise immediately, the contract having been let to McHolland Brothers. The building will be three stories and of brick. The dimensions are 56 x 62 ft.

**VALE.**—E. D. Gallagher, here, plans immediate construction of a large capacity reducing plant at Vale, to develop his company's nitrate properties.

### Pennsylvania

**BETHLEHEM.**—The Bethlehem Steel Company has commenced the operation of a new open-hearth furnace with daily capacity of about 200 tons. The plant has been in course of construction during the past year, and will augment the tonnage at the works by about 60,000 tons a month.

**BLOOMSBURG.**—The American Car & Foundry Company is building a large addition to its plant to handle an order received from the Government for munitions. New machinery will be installed.

**MARCUS HOOK.**—The Benzol Products Company is reported to have acquired a large tract of property in the Claymont district to provide for the construction of a new chemical works. The General Chemical Company as well as the National Chemical & Aniline Company are affiliated with the Benzol company.

**PHILADELPHIA.**—The Main Belting Company, 1219 Carpenter Street, will soon call for bids for the erection of a new one-story addition to cost about \$20,000. W. H. Castor, Stephen Girard Building, is architect.

**PHILADELPHIA.**—The Gorgas-Pierle Manufacturing Company, East Allen Street, manufacturer of oils, etc., has awarded a contract for the construction of a new five-story plant, 75 x 156 ft., at 144-164 East Allen Street, to cost \$100,000. The Turner Concrete Steel Company, Philadelphia, contractor.

**PHILADELPHIA.**—George D. Wetherill & Company, manufacturer of paints, etc., will build a new four-story brick and concrete addition to its plant, about 45 x 80 ft.

**PITTSBURGH.**—The Universal By-Products Company, Ferguson Building, is reported to be planning for the construction of a plant at St. Petersburg, Fla., for the manufacture of leather specialties from shark skins. The machine installation will cost about \$125,000, and the entire plant \$375,000. Norman Lawrence is consulting engineer.

**POTTSVILLE.**—The Eastern Steel Company is said to be planning for the erection of extensions to its plant to increase the capacity about one-third. The proposed additions are estimated to cost about \$500,000.

**READING.**—The Carpenter Steel Company is planning for the construction of several additions to its plant. Property has been acquired on other side of the Schuylkill River for the proposed works, and plans are being prepared for a reinforced-concrete bridge to connect the plants.

### West Virginia

**PARKERSBURG.**—The Beechwood Chemical Company is planning for the construction of a new three-story plant, about 54 x 110 ft.

**PARKERSBURG.**—The Cleveland Chain Manufacturing Company, Cleveland, Ohio, is said to have acquired a site for the construction of a local chain manufacturing plant to be used as a branch factory.

**SOUTH CHARLESTON.**—E. C. Klobstein & Sons Company, 644 Greenwich Street, New York, is making rapid progress in the construction of its new plant. The

works will specialize in the production of chlorine products, caustic soda, calcium chloride, and kindred specialties.

**WHEELING.**—The acid plant of the United Zinc Smelting Corporation's mammoth plant at Moundsville was put in operation the first week in August. The acid made is 60 deg. sulphuric. The following are the several parts of the plant in operation at the present time: Pottery, machine shop, kilns, ore crusher and acid plant. The roasted ore which is obtained at the Moundsville plant will be shipped to the corporation's plant at Clarksburg until the furnaces at this plant are completed. The two products made are zinc and sulphuric acid. When the furnaces are finished both these products will be made and the first unit will then be in full operation. The smelting plant with its connecting railways and storage houses covers nearly fifty acres of land and represents an expenditure of approximately \$1,000,000.

### Washington

**BELLINGHAM.**—What may prove to be a rich strike of tellurium in the Mount Baker region was uncovered at the Boundary Gold mine recently. Isaac D. Sperry, president of the Boundary-Golf Company owns the property.

**CHEWELAH.**—The manufacturing department of the Northwest Magnesite Company was expected to be placed in commission about Aug. 15. The investment of the company in improvements will be \$260,000, including the erection of buildings to cover five acres, equipment and a tramway. Plant will be used in the refinement of magnesite and in the manufacture of magnesite specialties, including paper making. The production of magnesite has become a new industry for the State, and provided a new tonnage for the railroads. Company is shipping 10,000 tons a month.

**COLVILLE.**—A corporation being formed by Thomas W. Cole of Chicago and others, will build 14 miles of railroad into the magnesite district near Valley, Wash., in Stevens County. About \$1,000,000 will be invested in the enterprise. Mr. Cole is connected with the American Minerals Production Company, one of the magnesite corporations operating in Stevens County. The new corporation will be known as the Spokane Valley & Northern Railway Company, with capital stock of \$2,000,000.

**IRONDALE.**—The old iron smelter at this place will be in operation by the middle of September, according to announcement of the Pacific Coast Steel Company, which recently took over the holdings of the Western Steel Corporation, moving the rolling mills and open-hearth furnaces to its plant at Youngstown. The furnace has been overhauled and will be utilized in smelting about 20,000 tons of Chinese iron ore brought from the Orient by the Western Steel Corporation. Company plans to experiment with new process in reducing ores, which if successful, will insure continuous operation of the smelter. After the Chinese ore is exhausted ore from British Columbia and other points will be used. The product of the smelter will be sent to Youngstown, where it will be converted into steel at the company's plant.

**SEATTLE.**—The Puget Sound Art Glass Company has recently received an order for 3000 port lights for submarine chasers and other boats under construction at Bremerton, the Puget Sound Navy Yard. Company has recently established its plant in quarters on Westlake Avenue where it has 4000 sq. ft. floor space.

**SEATTLE.**—The Star Brass Works has enlarged its plant more than 50 per cent and increased its payroll 60 per cent, as the result of unusual demands for machined brass products. Company has recently moved to its new \$8,000 plant at 1039 Railroad Avenue, and will add to its lines of manufacture several new types of brass machine products, making it the largest factory dealing exclusively in machine brass products in the Pacific Northwest.

**SPOKANE.**—Stockholders of the Canada Copper Corporation have received notice of a special meeting to consider details of the proposed 3000 ton daily capacity concentrator.

### British Columbia

The value of metals produced in British Columbia in 1917 it is believed will be 25 per cent greater than that of 1916, which was \$42,290,000. The increase would be greater, but for the interruption of smelting operations following the strike of coal miners. The strike affected the operation

of three smelters, the Granby at Grand Forks, the British Columbia at Greenwood and the Consolidated at Trail—only the copper furnaces were affected at the latter point. All were restored to service recently, and operated to capacity.

The Granby Consolidated Mining, Smelting & Power Company, Grand Forks and Anyox, B. C., produced 3,147,886 lb. of copper in June. This compares with 3,159,284 lb. in May, the banner month. The production of June was made solely by the Anyox plant. Grand Forks plant resumed operations two or three weeks ago after an idleness of about three months, due to coal and coke shortage. Earnings of the Granby company in June were about \$600,000, based on 29 cents a pound for the metal and cost of 11 cents for production. Company consumes about 6500 tons of ore, and similar amount of coke during a month. The most serious drawback to operations in British Columbia is the extreme uncertainty of the coke supply. The Crows Nest Pass coal fields are the only interior source of supply, and these mines appear to be almost constantly hampered by strikes, explosions or labor troubles. It is reported the Granby company, the largest single consumer of coke, proposes to go directly into the coal mining and coke-making industry to take care of the situation for its own needs. It has recently acquired 2000 acres of choice coal lands near Cassidy's Landing in the vicinity of Nanaimo, at a cost of \$700,000, and proposes to expend \$500,000 in improving them. At Anyox the company has a large steam auxiliary plant to supply power, when water supply is low. Its coal mines can thus supply immediate steam requirements when called upon.

**TRAIL.**—An average of 1600 tons of ore is daily being treated at the Trail smelter, and 2000 tons of high and low grade ore is passing through the Rossland smelter where for a number of years business has been at a low ebb. Labor in Trail is scarce, and wages high. Ore receipts at Trail during the last week in July totaled 9079 tons, the largest in many months. Settlement of the strike in Crows Nest and resumption of the coke supply are responsible for the increase. Total for the year to date is 200,237 tons. Important things are expected from the new oil-flotation process of smelting ores by which over 86 per cent of the mineral is extracted at Trail. It is stated that the new process has become so successful that practically all of the dumps are being repicked, and the low-grade ore, hitherto deemed of little value, is now being utilized with satisfactory results.

The Greenwood smelter of the Canada Copper Corporation will resume operations shortly. A coke supply for the operation of two furnaces has been arranged. One furnace was operated by the company for some months prior to the shut down caused by the Crows Nest strike.

**POINT GREY.**—Work is progressing on erection of the new Graham Products Company's plant at the foot of Oak Street, on the north arm of the Fraser River. Main building will be 50 x 150 ft. Eight evaporating kilns will be built.

**COPPER MOUNTAIN.**—The little test mill of the Canada Copper Company here is making a carload of concentrates weekly.

**KAMLOOPS.**—An option on a group of molybdenite claims has been taken by a group of European capitalists, and development work on a large scale will be undertaken. Claims are owned by Charles A. Mackay of Kamloops, Harold Chapman of Princeton, et al.

**VICTORIA.**—Plans are being worked out by city hall officials for the utilization of waste sawdust from the mills of the city, distilling it into cooking and illuminating gas.

**KASLO.**—The manganese deposits in the Kaslo district are being rapidly developed, and are proving of great value. The Bilrowe Alloys Company of Tacoma, Wash., has a contract to take 1000 tons of the product, and is urging the shippers to rush it through. Values are said to be good.

## Manufacturers' Notes

**MCCARTHY DRILL & TOOL CORPORATION** of Toledo, Ohio, with executive offices at 30 Church Street, New York City, has purchased the Toledo Drill & Tool Company, which has just moved into a new and enlarged fireproof two-story structure, where they have arranged to turn out large quantities of high-speed drills in addition to a full line of cutters and reamers. The McCarthy Drill & Tool Corpora-

tion has added new machinery and equipment so that they are in a position to produce vast quantities of high-speed twist drills with its new and modern machinery, and is now open to take on contracts and make prompt delivery for both millimeter and inch size high-speed twist drills.

**THE KALBFLEISCH CORPORATION** announces that it has a greatly increased output of permanganate of soda solution, and is now prepared to fill orders promptly for carload lots or less. A sample of the permanganate of soda will be shown at the coming National Exposition of Chemical Industries at the Grand Central Palace during the week of September 24.

**GLASS CO. ELECTS OFFICERS.**—At the annual meeting of stockholders and directors of the Johnston Glass Co., held at the general offices of the company, Hartford City, Ind., officers and directors were re-elected as follows: J. R. Johnston, Pittsburg, president; George A. Schlostein, South Charleston, W. Va., vice-president; George T. Fulton, Hartford City, secretary-treasurer. Directors: S. B. Fleming, New York City; John A. Jay, Kokomo, Ind.; Henry C. Mackney, Chicago; C. H. Hubbard, John C. Leonard and O. H. Hiatt, all of Hartford City.

## Manufacturers' Catalogs

**CARRIER AIR CONDITIONING COMPANY OF AMERICA**, Buffalo, N. Y., has issued a booklet entitled "Keeping Cool in El Paso." It describes air fans and washers in use in this city. The company has also issued a folder entitled "Look Inside for Details," which is so made that it shows the actual construction of the carrier air washer.

**UNIVERSAL VALVE CO.**, Burlington, Wis., has issued a booklet describing a swivel joint for use in steam, air, gas and ammonia lines, which requires no packing.

**SPRAY ENGINEERING COMPANY**, Boston, Mass., has issued Bulletin No. 311 describing the Spraco pneumatic painting equipment.

**BUFFALO DENTAL MANUFACTURING COMPANY**, Buffalo, N. Y., has issued a new catalog B-50, which is a most valuable reference work. The company is celebrating its fiftieth anniversary in the manufacture of high-class specialties for the chemical laboratory, including blast lamps, Bunsen burners, vacuum pumps, etc.

**WALTER A. ZELNICKER SUPPLY CO.**, St. Louis, Mo., has issued Bulletin 221, listing offerings in rails, locomotives, cars, cranes, pipe, piling and tanks.

**LINK-BELT CO.**, Chicago, Ill., has issued Book No. 361 entitled "Some Facts About Roller Chain Drives" and Book No. 326 describing Link-Belt "TT" class roller chains for tractors and trucks.

**C. G. BUCHANAN CO., INC.**, 90 West Street, New York, has issued Bulletin No. 10 describing its all-steel type "C" Buchanan crusher.

## Other New Publications

**TALKS TO PLATERS.** Given before the Bridgeport branch of the American Electroplaters' Society by F. C. Stanley. Published by the Bridgeport Branch. R. F. Clark, Box 671, Bridgeport, Conn., sec-treas. Price 50 cents.

**GAS CALORIMETER TABLES.** Circular 65 of the Bureau of Standards, Washington, D. C. Price 5 cents.

**MARKETS FOR CONSTRUCTION MATERIALS AND MACHINERY IN VENEZUELA.** By W. W. Ewing. Special Agents Series No. 144 of Bureau of Foreign and Domestic Commerce, Washington, D. C. Price 10 cents.

**LIMITS OF COMPLETE INFLAMMABILITY OF MIXTURES OF MINE GASES AND OF INDUSTRIAL GASES WITH AIR.** By George A. Burrell and A. W. Gauger. Bureau of Mines Technical Paper 150.

**STANDARD SAMPLES FOR THERMOMETRIC FIXED POINTS.** Bureau of Standards Circular No. 66.

**THE MINING INDUSTRY IN THE TERRITORY OF ALASKA DURING THE CALENDAR YEAR 1915.** By S. S. Smith. Bureau of Mines Bulletin 142.